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Automatic Data Processing

▶ *John Diebold Answers Twenty Questions on ADP*

▶ *The Next Decade of Computing Machines*

▶ *A Calculator Controls 32,000 Items at Vauxhall*

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An English Electric executive checks work at the company's computer centre in the Strand (for full story, see page 33).

AUTOMATIC DATA PROCESSING

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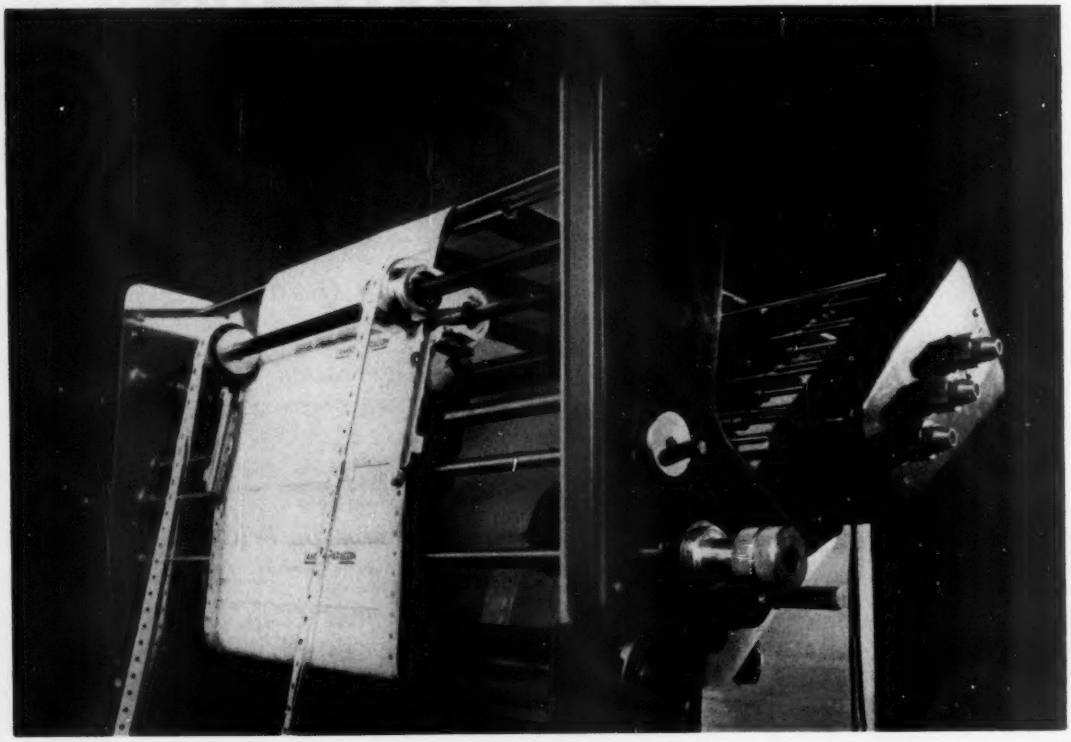


Our Role in the Electronic Revolution

THE launching of this journal comes at a time when commerce and industry are undergoing technical change so swift and radical that for once the term ' revolution ' can be used without exaggeration. And, as John Diebold points out in his article which begins on page 9, the outcome of this revolution will be that leisure will become the centre of life rather than the fringe.

Such a state of affairs is still, however, a long way off. Indeed, if it is to come about at all, there will have to be a greater measure of understanding than ever before between the two groups who will lead the revolution—the managers and the scientists.

This, then, is the backcloth against which *Automatic Data Processing* begins regular monthly publication. Its aim will be to bridge the gap between these two groups so that the men who have to make the important decisions in any company will be able to understand and assess that which the vision and ingenuity of the scientist have made possible. Conversely, though this will not be its main purpose, we hope that this new journal will bring to the technical man some idea of the day-to-day and long-term problems which confront the top executive.

Automatic Data Processing will set about this task in the following way. First, its language will be simple, direct and, as far as possible, non-technical. Second, it will carry straightforward, up-to-date accounts of successful ADP installations and will describe in detail how such installations are operated. Third, it will publish a regular feature on management training for ADP, as well as features on the basic principles of computer design and programming. Fourth, it will cover fully and objectively new thinking on the subject and the new uses to which computers and ancillary equipment will inevitably be put. Last but not least will be the news pages covering commercial developments, new installations, techniques, courses and exhibitions, and so forth.

The new journal's range will span the office and the factory floor, the laboratory and the training college, the airport and the railway control centre, the banks, the warehouses and the shops. It will in fact search in every field where news of promising and useful ADP applications may be found. Nor will it shun controversy. Dr. Booth's article, which begins on page 16, contains several controversial suggestions and predictions.

An opinion quite commonly held both here and abroad is that Britain is not so ADP-conscious as she might be. Whatever might have been the case in the past, this is certainly not true today. The newspapers and management journals are full of advertisements for computer engineers and programmers, and the training courses—whether run by technical colleges or the manufacturers themselves—barely keep up with demand.

Interest alone is not enough, however. The benefits of ADP systems promise to be great but they will have to be earned. And this means, to be quite blunt, that the standard of executive performance will have to go up. This in turn means knowledge, so the ' once-for-all ' appreciation course will therefore have to be supplemented by a regular supply of news and ideas. It is this supply which we intend that *Automatic Data Processing* shall provide.

ICI Paints Division select IBM 650 'TAPE' COMPUTER

1

1 SIR DAVID ECCLES, P.C., K.C.V.O., M.P.,
President, Board of Trade.

It gives me pleasure to contribute a message of welcome in the first monthly issue of a journal which is to be devoted to the subject of automatic data processing.

Managements at home and abroad are giving thought to the significance of automatic data processing within their organisations. There is no doubt that applications of A.D.P. techniques will increase in commercial, industrial and scientific fields, and manufacturers in Britain offer a wide range of excellent equipment.

The Future of ADP. . . . .

2

2 THE EARL OF VERULAM, M.A., J.P.
Chairman, British Institute of Management.

I am delighted to know that the first number of *Automatic Data Processing* will be published in mid-March. Whilst you will be breaking new ground—matter for congratulation, in any case—you will also be providing a journal which will fill a real want, in the light of the inevitable and necessary increase in the use of electronic computers in this country, and indeed in the British Commonwealth, in the years immediately ahead. I know that all concerned with B.I.M. would like to wish you well in this new venture and to congratulate you on your enterprise.

3

3 MR. B. F. LEVETT,
*President, O.A.B.E.T.A.**

Until man is the complete master of the machine or mechanical installation which is to be his servant, he is never in a position to obtain from it the maximum of which it is capable. This dictum, so true generally, applies especially when referred to electronic computing, for at this stage in its development there is no one to whom its *full* potentialities are yet an open book.

So, a medium which will disseminate widely knowledge both of achievements of the equipment on behalf of industry and commerce and at the same time news of technical developments as they occur, is bound to prove of great value to manufacturer as well as user. I therefore welcome very warmly this first monthly issue of *Automatic Data Processing*.

4

4 MR. FRANK BOWER, C.B.E.,
President, The Association of British Chambers of Commerce.

I am pleased to send greetings and best wishes for the first monthly issue of *Automatic Data Processing*. Mechanisation in the office must keep pace with automation on the shop floor if United Kingdom producers are to remain competitive in world markets.

'Keeping your Office in Step with Technical Developments' is the theme of a Conference to be held in the Festival Hall in April 1959. This is a theme which *Automatic Data Processing* will in its normal course foster and encourage.

5

5 SIR NOEL HALL,
Director, The Administrative Staff College.

I am very glad to join those welcoming *Automatic Data Processing* and wish it and its contributors luck in playing their part in ensuring that British computers take their full place in improving the efficiency of industry and commerce both at home and overseas.

6

6 THE VISCOUNT DE LISLE, V.C.
President of the Office Management Association.

It would be a great pity if the possibilities which this new development has opened up were to be lost through an unwillingness to exchange experiences, for we have found in the Office Management Association that there is a great deal which can be gained by the pooling of knowledge on this and similar subjects.

I am sure that *Automatic Data Processing* will provide a forum for such exchanges of experience and I would like to wish it every success.

* *Office Appliance and Business Equipment Trades Association.*

THE ADP REVOLUTION

JOHN DIEBOLD, AMERICA'S "ELDER STATESMAN OF AUTOMATION," HAS ACCEPTED OUR INVITATION TO BECOME CHIEF ADVISORY EDITOR OF *AUTOMATIC DATA PROCESSING*. HERE, IN A SPECIAL INTERVIEW, HE SUMS UP PRESENT THINKING ON ADP AND GIVES HIS OWN IDEAS ON FUTURE DEVELOPMENTS

John Diebold Answers Twenty Questions

1. *It is often claimed that the application of computers to industry and commerce is going to create a new 'industrial revolution.' Do you think this is a true assessment or an exaggeration?*

J.D.: The Industrial Revolution was revolutionary because it created a whole new way of life. Like the Industrial Revolution of the 1750's, the Second Industrial Revolution of the 1950's also has its crop of machines.

The new machines of automation are bringing about a world in which fewer and fewer people will work in factories. The work week will be greatly shortened and the pace of life will slow down. Less monotonous and tedious work will still require human effort, but leisure will become the centre of life rather than the fringe.

The guiding function of man which was required in technological revolution is being done away with through 'feedback' in this one. This is fundamental to the automation revolution. By linking up machines that store information, machines that count and can calculate maxima and minima within fractions of seconds, and machines that are more sensitive to light, touch, heat, smell, or even taste, than any human being could ever be, you arrive at a machine which can carry out a whole sequence of operations with uncanny speed, precision, and 'sensitivity.'

For example, we would not have atomic energy if it were not for feedback control. No man could operate valves or hand controls deep within the flux of the atomic reactor. Nor would the manufacture of polyethylene be possible without the use of feedback control. While Americans have succeeded in building the most efficient factories in the world, their offices have lagged sadly behind. Automation is going to affect that mightily too.

Like the pioneers of the Industrial Revolution in the 18th century, we face a world in which only one thing is sure: change, fundamental change. **We are leaving the push-button age and entering an age when the buttons push themselves.** Farsighted and aggressive managements see not only the possibility of decreasing operating costs, but also of entering the field with new products and new services. Entirely new markets are coming into existence, and alert businessmen are already seizing the opportunities that they see before them. I think it is fair to say that automation offers as great a challenge and reward as any which industry has ever known.

★

2. *Would you care to be specific on some of the ways in which you think the advent of automatic data processing will force managements to rethink their jobs?*

J.D.: First there will be changes in operating environment of the manager:

1. Data will be immensely more precise. Tools will be available to supply exact, up-to-date information on the specific problem involved. It

will no longer be necessary to wade through a plethora of reports.

2. Reactions to a decision will be much more rapid and much more measurable. It will be possible to pinpoint effects of decisions—good or bad—with much greater precision. It means not only that a manager's performance will be subject to closer scrutiny, but that the manager himself will have to be capable of recognizing the significance of the results and of adjusting his action quickly.

3. More data will be available and it will be available in different form than now. File maintenance techniques and data preparation techniques will permit access to a great many more facts. The manager will have to know how to use them. The information available will present the entire picture, and the manager will have to be ready to think in terms of the data which represents the entire picture—the close interdependence of every phase of a business operation.

4. There will be much more emphasis on data utilization. Today an ability to make correct decisions most of the time on the basis of inadequate information is a mark of the good manager, even on the middle management level. In the future, the good middle management executive will be distinguished by his ability to utilize all the data before making a decision, and then to make a decision in accordance with the dictates of the data.

Second, areas for decision making will change:

1. Routine decisions will become fewer. Given certain basic information as to timing, criteria, requirements and standards, many routine decisions will be generated by the system. These will include scheduling, shipping methods, purchase requirements and personnel requirements.

2. Decisions that are made will be more basic and important. A far greater proportion of the decisions will be the fundamental ones that determine over-all performance. Therefore bad decisions will have greater ramifications, and the proportion of right to wrong decisions will have to be higher than today.

3. Effects of even minor decisions and actions will not be confined to a single activity or department. Actually the entire concept of departments will no longer exist, and action will not take place in specific segments of a company, but will be part of a continuous interdependent process of production and information flow. **Managerial decisions will not necessarily become more technical, but they will become more critical at every level of management.**

★

3. *Already in Britain a divergence of opinion has arisen between those members of management directly concerned with the planning and operation of data processing systems and those whose jobs are affected only indirectly. Does your experience in the U.S.A. point to a similar situation there?*

J.D.: It is probably true that most data processing activities in the U.S. started with insufficient authority and insufficient attention. Thus there have been divergences of opinion, but these can be overcome in two ways. First, by education. Not only must the data processing managers be given a thorough understanding of their role, but also those whose jobs are affected indirectly must be shown the potential and objectives of automatic data processing and the results they may reasonably expect.

The second requirement is that top management take a sufficient interest in ADP so that they can make valid decisions on the proper place of the data processing organization in the company. This place will be different for nearly every company.

★

4. *ADP installations supply managements with 'facts, not history.' Will this demand a change in the qualities needed in senior executives?*

J.D.: Truly fruitful results from automatic data processing systems require a fundamental change in approach, an understanding that the best applications are not the mechanization or streamlining of existing procedures, but a willingness to rethink the problems of an entire business in terms of ultimate goal and final product.

These are not technical problems. They are problems of method, organization and attitude and they require managerial imagination, skill and experience rather than technical proficiency. Automation is one of the critical areas in which management must *manage*. But instead of realizing this crucial point, management has become so intimidated by the complexity of this new hardware that it has allowed technicians to

take over not only the operation of the machines but the actual decisions about how they are to be used.

Bringing in engineers and scientists as managers is not the solution. When presented with sufficient data, as management will be through automation, the same set of personality characteristics may not produce the best management. A new businessman must take over whose very education requirements are as yet unknown. The central functions of management will remain organization, motivation and control of human effort.

★

5. *Most technical men specializing in computers and automatic control plant have deplored the lack of real interest of which they say managements have been guilty. They claim that all too often top managers and directors have been blind to the great benefits such systems can bring or have been too short-sighted to authorize the purchase of the equipment. To what extent, if any, do you think these accusations have been justified?*

J.D.: Technical men specializing in computers see the technical possibilities that such machines afford. Top managers and directors are faced with the problems of running the company. In the great majority of cases in the U.S., top management has been quite ready to pay attention to the possible benefits from computers. However, in many cases top management will see obstacles and will be afraid of risks that may not be completely realized by the technical people.

The actual trend in America seems to have gone from one extreme to the other. Several years ago top management authorized the acquisition of equipment without insisting that adequate preparation take place. Such actions resulted in some bad experiences, and, as word of these bad experiences spread, top management took a position of excessive caution. At the present time the cautious position is in the ascendancy.

A lot of the blame for this can be placed on the technical people because, in their enthusiasm, they did not make sufficiently clear to top management the magnitude of the task of preparing for a data processing installation. The one area where management may be shortsighted is in failure to give adequate attention to the so-called intangible benefits that can arise from an ADP installation. This is manifested by insisting that computers break even on a pure clerical cost basis.

6. *Who should be in charge of a data processing department—a technical expert or a top manager with broader experience?*

J.D.: For a business data processing installation, there is no question that a manager rather than a technical man should be in charge. He should make every effort to school himself sufficiently in the technical aspects of automatic data processing so as to be able to perform his work, but he should not be primarily a technical man. Some of the reasons for this conclusion are as follows:

1. The good business data processing activity will encompass nearly every phase of company activity, and it requires a man who is used to thinking in company-wide terms to give proper guidance.

2. The main questions, or at least the crucial ones, are business questions—What type of information is needed? What cost-savings-profit justification exists for each application and each extension of computer activity? How can the computer centre make maximum contribution to the company's profits?

3. Even many of the actual questions of operating the data processing centre are managerial—personnel policies, budgets, performance standards, assignment and planning of work, and training policies.

4. The data processing manager must have influence. Only a manager who is respected by other department heads, and who is considered a sensible businessman, can 'sell' computer applications to sceptical colleagues. This is a vital function for acceptance of the computer.

5. A proper data processing organization calls for at least one 'technical' supervisor under the manager. Even medium-sized computer installations should in most cases have an 'operations supervisor,' and any group of programmers should have a senior who can function as a working supervisor or 'straw boss.'

6. The manager should have a realistic attitude toward his equipment. In many instances, once the computer is installed, everybody wants to 'use it.' The manager must be able to evaluate each suggested use that differs from the original plan, which was presumably carefully drawn up. He must also have the stature to make his decision prevail, assuming he is correct.

7. *A number of computer manufacturing firms in Britain strongly advocate that prospective customers think in terms of integrating all their data processing operations. From your experience, do you think this is a sound approach?*

J.D.: If automation is to meet its potential goals, there should be integration of all data processing operations. Automation and its related technology present us with the means to build a machine system that can handle a great number of information-processing tasks simultaneously. For example, processing new orders, scheduling production, checking raw materials inventory, placing orders for new material, cost distribution and machine loading can all be handled as part of the same interrelated problem—which of course they are in the real world. **What it means is that we now have the ability to organize our work in closer relation to reality. We no longer need to make the organization of paper work as much of an abstraction from day-to-day happenings as it has always been.**

★

8. *Are you against a computer being used for single jobs—such as payroll, or stock or production control?*

J.D.: If the machines of automation are used only to do more rapidly what is already being done today in more conventional ways (payroll, inventory, etc.) the real problem will not be met.

★

9. *Are there any industries or businesses which, in your opinion, lend themselves particularly to the profitable application of automatic data processing systems? If so, could you specify these?*

J.D.: The industries or businesses which lend themselves particularly to the profitable application of ADP are characterized by one or more of the following situations:

a. They have large volume, well defined billing (invoicing) type applications:

1. Insurance companies—premium billing
2. Public Utility companies—utility billing
3. Railroads—(inter-line settlements etc.)

b. They currently spend more than $200,000 per year on data processing activities which do not require judgment decisions or personal contact with outsiders.

1. Many large manufacturers (inventory records, payrolls, sales analyses, cost accounting, etc.)
2. All of the types of concerns mentioned under **a.** above
3. Some large wholesalers

c. They have a fixed time limit in which to accomplish their application cycle; and the application requires up-dating a file. Where this is the case and volume is increasing, it may become impossible to accomplish the job with either people or punched card machines.

1. Large wholesalers (inventory control and billing)
2. Large manufacturers (sales analysis, inventory control and scheduling of production)
3. Large retailers (buying trend information and inventory control)
4. Large mail order houses

d. They have a large amount of engineering work or design calculations which, if done by computer, will place them in a better sales or cost position.

There are many other areas where ADP can be used profitably such as in production scheduling; however, it is usually true that these applications are not now very well defined (which they must be if a computer is to do them) hence we cannot say that ADP lends itself particularly to profitable application in these areas. Though it must be said that once these problems are defined, ADP may produce its greatest profits in performing such applications.

★

10. *Should a firm which has decided to introduce an ADP system get the computer in as soon as possible and learn to live with it and use it? Or should it appoint a special team to prepare the ground?*

J.D.: The installation of automation equipment should not be made unless a thorough understanding of the business itself, and the functions and needs of its operations, underlies it. **While the businessman may regard the specialized knowledge of the engineer with something approaching awe, the engineer all too frequently regards the unfamiliar processes of business as something that can be mastered in a few months.**

Nothing could be more erroneous than to assume that the first step in applying automation is selecting the machines. The very phrase

'feasibility study,' so often used in connection with the study preceding installation of a computer, frequently serves to imply to those conducting the study that they are trying to find an application for a computer. **Their objective should be to design the best possible information and communication system for meeting the needs of the organization, whether it relies upon a computer, a simple manual and machine system, or entirely upon humans.** The whole concept of systems analysis and design, basic to automation, requires a careful and detailed plan for the entire organization if the benefits realized are to be more than marginal.

So many examples of poorly used computers exist at this time because initially machines were bought with the obvious intention of applying a single, stock model machine. Too much has been left to the sales representatives of the equipment companies. But management must not only concentrate on the systems concept of automation. It must also be familiar with the machines that are available.

★

11. *What would you say a reasonable time for preparation?*

J.D.: There is no definite 'reasonable time' for preparation because this depends upon the scope of the job to be accomplished.

★

12. *Most of the publicity for ADP so far has highlighted its advantages in the administrative and commercial fields. But are there not also considerable benefits to be derived from automatic control systems in the production line? Where, then, do you think are the greatest benefits likely to be won?*

J.D.: ADP generally refers to the processing of administrative matters and the development of management information. Automatic control systems for a production line are generally considered in a different category, either under process control or factory automation. The division is somewhat arbitrary, especially since the future promises a much closer linking of the factory with the office.

However, even ADP can produce savings in the production area through better planning and control. Better planning and control bring about full utilization of capital equipment, lower inventories, and better quality control.

13. *All digital computers are of basically the same construction. In your view, then, once the size of the machine required has been decided upon, is it really necessary for a firm to make a meticulous study of the market in that particular size?*

J.D.: In answering this question one might well ask how the size of the machine required was decided upon. Also one would further have to ask what criteria were used to classify machines by size.

In our view, when we are choosing equipment to perform business data processing, the following points must be considered:

a. For any given set of repetitive business problems there is one best system from the standpoint of the best being the simplest system.

b. For any given "best" system there is one computer which provides the most economical implementation of that system.

c. The primary machine characteristics which affect business problems are:

1. Sequential file processing speed and characteristics (magnetic tape)

John Diebold, Chief Advisory Editor of *Automatic Data Processing*, is founder and president of John Diebold & Associates, Inc., a group of management consulting companies with a world-wide professional practice in automation and automatic data processing. At 32, Mr. Diebold himself is an internationally recognized authority on automation, (he is one of the co-originators of the word) and is particularly concerned with the management and organization problems posed by this new field. Mr. Diebold pioneered many automation concepts, which are now accepted practice, and presented these in a book, *Automation*, which he wrote when he was 26 years of age. After leaving Harvard Business School, with degrees in engineering and economics and a Master of Business Administration with distinction, Mr. Diebold joined the Chicago firm of Griffenhagen and Associates. He later founded his own company and subsequently had the gratifying experience of buying the Griffenhagen organization, and merging it into John Diebold & Associates, Inc., as one of the operating divisions.

2. Random storage properties and speed of access
3. Input media and speeds
4. Output media and speeds

d. Determining the characteristics mentioned in c. above does not require meticulous study.

Thus we feel that a best system should be designed and that equipment should then be fitted as closely as possible to that system (modifying the system when necessary) on the basis of input, storage and output facilities. Of course, cost is also considered.

In summary, then, design the system, acquaint yourself with the information concerning cost, input, storage and output for all computers within your price range (as determined by present costs) and then choose the machine which best fits the system. **Spend your time on system design, not equipment comparisons.**

★

14. *Computers are now mainly used for producing answers in the form of figures. But for many commercial, engineering and scientific problems, a graphic presentation of alternative answers (from which a simple choice can be made) would be better. To what extent is this possible now? Are there any examples? And how soon is the change to graphic presentation likely to come?*

J.D.: Today's data processing systems generate large quantities of numerical data. Yet most businessmen find it easier to comprehend the relationship between statistical series and changes in rates of statistical series by looking at graphs and curves.

Automatic graph-plotting equipment actuated by punched cards is now being used for scientific and military purposes. In highway engineering, drafting is beginning to be replaced by display of computer output on a TV tube, preserved by photography. The windscreens of experimental jet fighter planes are today made in the form of flat TV tubes, which not only allow the pilot to see through them (as a normal glass pane would), but present him with a graphic display of things he cannot see—radar impulses showing terrain and enemy planes in colour. Such display methods will soon be used for presentation of business information to managers. They will be the output of the data processing systems of tomorrow.

15. *Approximately how many ADP installations have now been ordered in the U.S.A., how many have actually been set up and, of these, how many are working successfully? Do the figures indicate higher percentages of success with certain sizes of installation and with certain types of industry? Can you give examples?*

J.D.: ADP installations to date in the U.S.A. number more than 2,200. These include large, medium and small systems. In addition, more than 1,800 systems have been ordered, to be installed anywhere from several months to two or three years in the future. Unfortunately, successful installations do not come close to the total number in use.

According to a survey recently made by my own company, close to 46 per cent of the users of ADP equipment indicated that their results were falling short of their expectations. Generally speaking, the large-scale installations have been more successful than medium and small.

There is no question about the fact that scientific applications of computers have been more successful than business applications. In the area of business data processing, those companies with a very large amount of routine paper work, such as utilities and insurance companies, have had a high degree of success. Many of these installations are large scale, including *IBM 700* series and *Univac* systems.

Most of the new computers which have been announced in the past year are medium scale, but can be built up to large-scale systems. They have been designed with business data processing in mind.

★

16. *How do the costs of data preparation compare with other costs of data processing, and how is this comparison likely to affect the rate at which completely integrated ADP systems are introduced?*

J.D.: The costs of data preparation in relation to programming, installation, rental, etc., vary so widely from case to case that it would be misleading to state an average. However, we can say that the ratio of data preparation cost to total ADP costs decreases as the degree of system integration increases. This fairly obvious conclusion supports our contention that these data creation costs will hasten integration if each concern:

a. Keeps adequate cost records of ADP operations.
b. Charges the departments which use ADP services with the cost of ADP.
c. Has management which is aware of the benefits of detailed study and planning.
d. Has management which is willing to change traditional operating methods.

It must also be mentioned that much work is currently being done on such things as document sensing, tape perforating, data originating machines, etc. All of these developments should tend to increase the speed of integrated systems;

★

17. *What in your opinion should be the main features of management appreciation courses in ADP?*

J.D.: The main features of a course in ADP for management should be:

a. General description of computers.
b. Theory of integrated systems versus functionalized systems and how computers alone can allow integrated systems to operate.
c. Costs of planning, installing and operating computers.
d. Need for management participation and support of a computer study.
e. Benefits of ADP—faster results, greater accuracy, greater control, ability to perform calculations hitherto considered impractical, etc.
f. Inherent rigidity of highly automated systems.
g. The need for definition of problems, goals and economic yardsticks for measuring feasibility.
h. The need for detailed study and planning.

This can be accomplished in as little time as one day. However, the more time the better.

★

18. *The quality of the programming team can make or break an ADP project. What types of skill and experience should firms look for when selecting programmers, and what subjects should they be taught besides the obvious things such as the idiosyncracies of the machine they will be using? (For instance, do you think it is worth while to educate programmers in the company's history, traditions, problems and methods of operation?)*

J.D.: If there is sufficient distinction between a systems analyst and designer and a programmer, then it is not essential that the programmer be thoroughly versed in the company's history and methods of operation. The analyst, however, should be.

The following should be included in training for programmers: Detailed programming courses on machine to be received; theory of programme flow charting; theory of input-output controls; techniques of file maintenance-tape, drum; application training; coding methods; constructing test data; training in error correction methods; de-bugging techniques; advanced programme - analyzers, assemblers, compilers, generators, etc.; programme timing methods; tape identification methods; randomizing techniques.

★

19. *Do you consider it necessary for industrial management to install an ADP system in order to discover that it really needs automatic control and co-ordination of its production departments rather than a system for producing statistics?*

J.D.: The answer to this question is 'no.' If we said 'yes' we would imply that it is impossible to determine if a data processing system can be run efficiently without installing a computer. This is not so.

★

20. *What values do you attach to expenditure on equipment for giving computers direct access to events in production departments, as compared with expenditure on, say, faster printing machines?*

J.D.: We feel that developments in the area of communication between production events and the computer are vastly more important than the given example of faster printing machines. **In general, we feel that the two largest problems confronting computer systems development are those of communications between the computer and outside events, and the need for low cost, large size, rapid access, random memories.**

In one sense the need for memory is the most important in that direct communication may be of little value unless the data received can be immediately related to stored file data. And since the event data would not necessarily be in any given sequence we must have *random* access to the files.

Faster Machines — and Immense Possibilities

One of Britain's leading computer scientists tells how he sees the next ten years in ADP for science, technology and industry. A second article by Dr. Booth will appear next month.

by ANDREW BOOTH, D.Sc., Ph.D.,
Head of Birkbeck College Computer Laboratory

Dr. Booth. "Speeds at the moment are just about the same as those we hoped for on the machines which were designed in the 1940's."

SEVERAL speakers and quite a few authors of papers and articles in the past year have been talking of so-called 'second generation computing machines.' Here, I should like to examine the progress which is likely to be made in the field of automatic digital computation during the next decade and it is worth while saying that any claim that existing machines, and particularly existing machines which are commercially available, are second generation computers is, if not nonsense, at least grave over-statement.

In fact, anyone who is sufficiently interested to read the original literature and proposals, which were prepared just over ten years ago when automatic digital computing machines were in their infancy, will soon discover that the speeds and capabilities of the machines then proposed were just about those which are being attained on the latest computing machines.

What the true second generation computing machine is likely to look like and how it will perform on the problems which will be put to it will be discussed next month, but it seems useful first to describe the characteristics of the machines

General view of one of the larger new computers—the Emidec 2400 *transistorized machine made by E.M.I. Electronics Ltd. Engineers are working on the racks of equipment which will eventually form the complete machine. When completed, the computer will consist of between 30 and 40 racks and will be capable of 'absorbing' all the information in the* Encyclopædia Britannica *in less than four minutes.*

which we have at present and to look at some of the problems to which they have been applied. By doing this the technical innovations and expanding spheres of application of computers in the next decade will come more into perspective. Furthermore, it is quite useful to make such a preliminary assessment of present day attainments in view of some exaggerated claims which have been made.

First to deal with two old war horses now retired from the fray. Early computing machines in this country tended to fall into one of three classes: those which used mercury delay lines for storage, those which used secondary emission phenomena and those which used magnetic drums.

Of these classes, the first two—those relying upon delay lines and cathode ray tube storage—are now defunct. The mercury delay line, despite its undoubted advantages of over-all reliability and moderately large signal recovery suffers from very grave disadvantages of bulk and weight, and for this reason, with one exception, it has now been abandoned by computing machine designers. The secondary emission type of storage, making use of ordinary or modified cathode ray tubes, never appeared a particularly promising contender in the field of storage, and time has shown that its idiosyncracies make it quite unsuitable for use in large machine installations. Magnetic drums are still with us in one form or another and, as we shall see later, are likely to continue. On the other hand, it seems quite improbable that many more machines will be built, at least in the high speed range, where magnetic drum storage forms the sole memory of the device.

Looking next at the over-all picture of storage in modern machines we find first of all that the original von Neumann idea of a single storage organ sufficiently large to hold all data and instructions required to solve a problem has been more or less abandoned. It is replaced by hierarchical forms of storage in which the highest speed rank is formed by magnetic cores, the medium speed branch by a magnetic drum and the low speed, very large access part by magnetic tape.

It is worth mentioning here that for the large-scale storage of data, tape has two rivals which may or may not triumph in the long run. They are both magnetic in nature, the first the file drum and the second the RAMAC or 'juke-box' store.

The file drum is simply a low speed magnetic

drum using a very high packing density of data. This enables storage of the order of 5 to 10 million characters in ordinary alphabetic code to be held in a single unit about two feet in diameter and the same length. The RAMAC consists of a number of discs containing tracks of information and a single head which, by complicated electro-mechanical means, can be transported to locate any particular piece of data on any disc which is required.

The Versatile Transistor

Coming next to the internal structure of machines we find a clear trend and, to some extent, a clear cleavage. British machines by and large are still using hard valve, hot cathode techniques: American machines, on the other hand, are veering rapidly towards all-transistor construction.

The advantages of the transistor have been too frequently and widely publicised to need much comment. Suffice it to say that the transistor eliminates the hot cathode of the thermionic valve and thereby a large stand-by power wastage in the computing machine; it operates on semi-conductor principles which, in theory at least, should make for greater reliability, and, possibly most important of all, its impedance levels are between one tenth and one hundredth of those which are obtained with thermionic valves.

The effect of the latter characteristic should be that transistor machines will be far less liable to pick up stray electrical interference than were their hot valve progenitors.

Another aspect of the transistor, which has been widely discussed, is its small size. This may or may not be of advantage in everyday computers of the future, although it will undoubtedly play a part in the computers which are needed in space vehicles of the coming age, where small size and weight are at a premium. In more normal machines, however, the problems of lay-out where very small components are used are likely to out-weigh the advantages gained by undue miniaturization, so that, although machines will be reduced in size from filling a whole room, they are unlikely to go from filling a desk to filling a biscuit tin.

On the question of input-output to present day machines there is again a distinct cleavage. British machines still tend to use either punched paper tape or punched cards for both input and output, whereas American machines have veered almost entirely to the use of magnetic tape. The reliability and auditability of magnetic tape is still under vigorous discussion, although it appears that it is winning the battle and will soon find an accepted place in all computing installations but those of the smallest size.

Finally, the speed of modern machines. This tends to be such that addition and subtraction take between 10 and 100 micro-seconds on fast machines and between 100 and 1,000 micro-seconds on slow ones. Multiplication and division usually take between 30 and 300 micro-seconds on fast machines and between 300 and 30,000 micro-seconds on the slow ones. As we mentioned at the beginning, these speeds are just about the same as those which were hoped for and projected on the machines which were designed in the mid 1940's.

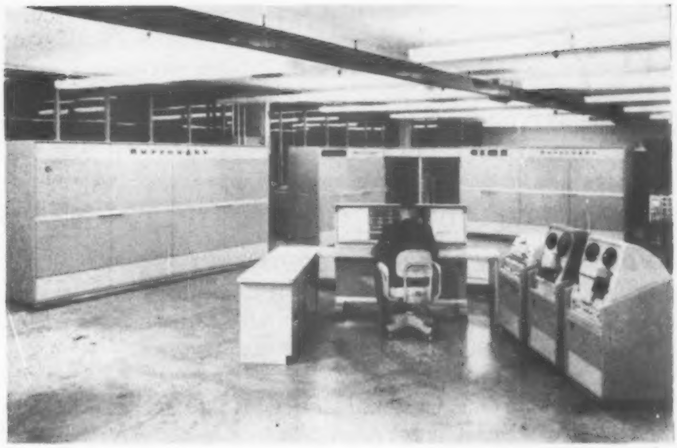
So much, then, for the technical characteristics of the machines. Nothing has been said about reliability, quoted figures for which vary from 60 per cent to 99 per cent. In all cases, however, considerable reservations must be made as to the way in which 'good' computer time is assessed. **It is probably fair to say that the best modern machines achieve about 80 per cent reliability, and it is equally safe to predict that this figure will be pushed to something like 99 per cent in the quite near future.**

Current Applications

We come now to a discussion of some problems to which machines of the past and present have been applied. It is convenient to divide these into two phases: Science and Technology, and Economics and Commerce.

In Technology it is only really in the past two or three years that important applications of computing machines have been forthcoming. When the first machines were installed in University laboratories, many of the problems which were tackled, whilst of considerable mathematical or pure scientific interest, were not of a nature which would make an immediate appeal to the technological public. For example, calculating various types of mathematical table, calculating such quantities as *pi* and *e* to many thousands of decimal places, and the investigation of the zeros of the Riemann Zeta function were some of the problems attempted.

In the last two or three years, however, many new applications have been forthcoming as computing machines were installed in industrial laboratories. Of importance in modern British technology is the design of atomic reactors, and at the present time



The Burroughs 220 *Computer System with two high-speed photo readers in the right foreground. These read perforated tape at a rate of 1,000 characters a second from a code density of 10 characters per inch by a photo electric process.*

several computers are in full time operation dealing with such problems as the stability of the control system, the optimum lay-out of control rods in a reactor matrix, the thermo-dynamic considerations which apply when low temperature reactors are used, and so on. In electric power generation and transmission, computers have now found a number of applications, both to the lay-out of grid systems and for finding the best way in which turbines and generators can be associated with nuclear reactors.

In the field of electric railway traction, trains are nowadays designed on a computing machine and provided with running schedules and characteristics which are worked out entirely by the machine. In one current piece of research a computing machine can run a test on a hypothetical electric traction locomotive at a speed which would, in the real situation, correspond to a locomotive speed of about 6,000 miles per hour. In the aircraft industry computing machines are in use at the present time both for calculations of stress and strain in structures and in the design of the gas turbines and jet engines which are finding an increasing place in the modern aircraft.

Computing machines have been applied to the design of optical systems and have resulted in the reduction of the aberrations of several classical camera lens systems by up to 50 per cent.

On the more scientific plane some of the modern applications of computing machines are of considerable intrinsic interest. A topical subject is that of the origin of the Universe and in this field recent calculations have shown the way in which stars, such as our own sun, evolve and the way in which they are likely to decay as the Universe becomes older.

Calculations of this type take some of the fastest of modern computers times of the order of one day for their completion. Again, in work on the structure of the nucleus—of importance for the fusion reactors of the future, computing machines are in use and the fastest machines at present available are kept fully occupied in government research establishments. **It is not unfair to say that without computers such thermo-nuclear devices as the Zeta could never have been designed.**

In more prosaic, but nevertheless important, fields computing machines have found application in the evaluation of molecular structure, both by X-rays and from purely theoretical considerations. One of the highlights of machine applications in the X-ray field was that to the evaluation of the structure of Vitamin B12 and, at the present time, machines are being used in the solution of problems of protein structure which forms a major step in progressing from classical organic and biochemistry to a discovery of the way in which the life process itself works.

We have already mentioned applications in pure mathematics. These are probably rather disappointing to the layman and even to the pure mathematician since there does not seem to have been any real application of a machine to original research work in pure mathematics.

Finally, as a sort of bridge between Science and Technology and Economics and Commerce, there is the work in my own laboratory on machine translation of language. This has now proceeded to the stage where at least for the language pair French-English respectable translations of technical

(continued on page 54)

Commentary

▶ *COMPUTER GAME FOR EXECUTIVES*

▶ *BANKS ADP MINDED BUT NEED SPECIAL EQUIPMENT*

▶ *NEW COMPUTER STORAGE DEVICES*

AS time goes on, computer appreciation courses for management will introduce all sorts of new gimmicks and techniques, but it is difficult to imagine at present a more effective way of putting over what a computer can do than the decision-making game run by I.B.M.

This game was pioneered by the American Management Association using an I.B.M. 650 computer, but the company has since developed its own version and has been holding demonstrations of it at its London headquarters in Wigmore Street. It is essentially for middle management and its object is to give these ranks an insight into the tactics and strategy of top management decision-making.

The game, in a nutshell, is as follows. Three firms are marketing an identical product (we are not told what it is) at a selling price of about £40. Each company has its head office and factory in a different area, but there is a fourth ' common market ' area from which no competitive firm is operating. The three companies start on equal terms and with good prospects, but the current selling price does not yield a very good margin in some areas and so the return on investment is small.

What each company has to try to do, then, is so to manage its resources that is secures a better margin. Sales potentials of the four areas differ but none of them is near saturation-point. Each company (represented in the game by a syndicate of students) is given all the information it needs—orders received, units sold, marketing costs in each area, production reports and estimates and current assets and income. From this information, it must decide what cash to allocate to production, transport, marketing, plant investment and research and development, and where and how to launch special sales efforts. Operating decisions are made to cover the next quarter's activities.

When a syndicate has made up its mind, its estimates and allocations are sent to I.B.M.'s computer centre (which is in the same building) and there these are processed on a 650 machine. A special programme has been written which tells how much the team would have made or lost in the forthcoming period had action been taken on its estimates.

What the game achieves primarily is that it makes members of the syndicate more fully aware of the delicate inter-action of the various factors involved in production and selling. And it is but a logical step to apply the same principles to a ' real-life ' situation. But without the computer to approve or warn in advance, the whole exercise would, of course, be quite pointless.

★

A report at the end of last year that the Banco di Roma had installed a very large computer, added to the fact that some American banks have been using computers for some time, may superficially suggest that British banks are not moving fast enough in the ADP field.

A strong corrective to this view was supplied in a recent article in *The Banker* by J. D. Cowen, a general manager of Barclay's Bank.

Like everyone else, the clearing banks (who are the largest units in the banking business) look to ADP as a means of saving money, yet one difficulty that they have had to face is that at present the cost of the special equipment that the banks will require cannot be assessed.

Nevertheless there are large savings to be made. One bank has estimated that approximately 40 per cent of its work could be done automatically with electronic equipment. Even if this figure were over-optimistic, considerable relief from the annual payroll bill would accrue from adopting

some ADP system, even after allowing for reasonable costs of new equipment.

Consequently the clearing banks are interested, provided:

—the special equipment they want can be developed;

—the special equipment is not so priced that the break-even point is too high.

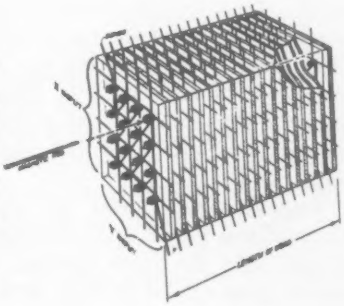
One possible approach to the clearing problem would have been to punch cheque details on to cards, and then to use well-tried punched card equipment to handle the sorting and listing operations. This approach has been rejected by the banks because it would have meant an extra operation (i.e. punching up) and a great number of cards. Also a cheque is a legal document and so to substitute this for a card at some stage would not have been satisfactory.

Consequently, the banks decided they would use cheques themselves as the input medium of any electronic system they devised. They have in fact decided to endow cheques with coding numbers and letters marked in magnetic ink, so that the figures can be read by a ' reading head ' and the naked eye.

The coding letters and numbers would provide all the vital information on the cheque in a condensed form; some of these—account number and branch code, for example—could be printed on before issuing cheque books.

★

COMPUTERS make much use of switching elements, and an important requirement is the presence of a ' store ' into and from which information can be read in a small fraction of a second. The switching elements are generally valves which consume considerable electrical power, and the ' store ' is usually made in the form of magnetic cores which are rather limited in their speed of operation.



Pin-size glass rods with magnetic coating serve as either switching or storing elements. They can record and release data at 25 to 250 microseconds.

New switch and storage elements are now under intensive development, and in some forms are near production. These have the advantage of very low power consumption, very small size, and two of those are likely to have extremely rapid operation.

The Bell Telephone Laboratories have developed an element which consists of a single wire 0.002" in diameter, made of the magnetic material, Permalloy. The wire is enclosed in an insulating tube around which are wound small coils. The wire is either twisted or stretched, and in the first case is called a ' Twistor.'

If digit pulses are applied to the coils, these pulses can be either stored or shifted along the wire in the form of a change in its magnetic state, by the application of pulses to other coils. The switching time is about 10 micro-seconds, and thus quite short. The storage capacity will probably be about 10 binary digits per inch.

Other laboratories are investigating the properties of magnetic films only a few molecules thick. When the magnetic film is so thin, its magnetic storage properties become such that information can be stored and extracted in a small fraction of a micro-second.

Another development is based on the extraordinary behaviour of a metal at extremely low temperatures. If the temperature is reduced to about 270 degrees below zero Centigrade, the electrical resistance completely disappears. This effect is called 'superconductivity,' and is made use of in a switch called the Cryotron, produced by the Massachusetts Institute of Technology.

A coil of insulated neobium is wound on a tantalum wire, both materials being kept at a temperature where they have no resistance. The current to be switched is passed through the tantalum wire. If a magnetic field is produced by energizing the coil, the superconductivity of the tantalum wire is destroyed, and the current through it is reduced. The switching time in recent versions of this device is about one micro-second.

I.B.M. and the Ramo-Woodridge Corporation are developing storage devices also based on the superconductivity principle, using a thin lead film on an insulating base. The operation of the storage element is dependent on the fact that if a ring of metal is made superconductive, any current set up in the ring will circulate indefinitely.

The access time for a store of this type is only a tenth of a micro-second. It is probable that these switch and storage elements will be extremely small and that about a million of these devices could be packed into a volume of one cubic foot.

The term 'computer centre' generally describes a digital installation, but here is an account of a thriving centre in Brussels equipped with analogue machines only.

This Analogue Centre Serves European and British Industry

by BERNARD MURPHY, Ph.D.
Director, European Computation Centre

Dr. Bernard Murphy, director of ECC's Brussels Computation Centre, was born and educated in England. He has had wide experience of computing machinery in America and Europe.

ON July 15, 1957, the European Computation Centre (ECC) of Electronic Associates Inc. was opened in Brussels, rather appropriately in rue de la Science. It was a pioneer effort to bring the benefits of large high-accuracy analogue computers within the financial reach of all Western European segments of industry and business, regardless of size.

Electronic Associates Inc. (EAI) of Long Branch, New Jersey, manufacture precision analogue computing equipment (PACE), and have supplied some 70-80 per cent of the American analogue computing market during the last three years. Their first Analogue Computation Centre was established in Princeton, New Jersey, in July, 1954, and a second centre was opened in Los Angeles in November, 1956. Thus the centre in Brussels is backed up by a large amount of experience for such a new field, and has established itself rapidly.

Brussels was chosen as the site for a Computation Centre and a European Sales Office (which is in the same building) because of its central geographical location with regard to the

more important centres of European industry, including Britain, its good communications, the outstandingly co-operative attitude of the Belgian government and the availability of trained personnel.

For EAI the Computation Centres are principally self-supporting research laboratories investigating analogue computing techniques and applications as well as the performance and behaviour of the standard machines under rigorous conditions. Also being investigated are improvements in the detailed design of PACE and new units and elements desirable for different types of problem. In addition the centres provide demonstration rooms for the sales offices, and train the engineers and technicians of purchasers of PACE in the operation and maintenance of their machines.

Where Analogue Computing Scores

The particular advantages of the analogue computer are:

(a) The formulation of problems is simple and direct. The closer the equations are to the basic physical system and the less processing done on them, the easier and more accurate the solution by machine becomes.

(b) Graphical presentation of results allows them to be assimilated readily.

(c) Its speed permits operation in conjunction with the machine of actual components of the system being investigated.

(d) Major changes in the system under study can be made with ease.

(e) The relative simplicity of the machine allows its processes to be readily understood by technical personnel.

(f) It is reliable, easy to maintain and can be readily increased in size.

Analogue computation is relatively new and to some extent has been overshadowed by digital computation, particularly in Britain. Its economic advantages lie in assisting engineers and scientists to be more effective by obtaining, in a minimum of time, a required result with accurately known tolerances and limitations. The financial return of such advantages is less obvious to the average management than that of replacing several pay clerks by machinery. Hence the principal users of ECC tend to be large companies with well-established research and development groups. Many are in the newer fields, such as aircraft, missiles, nuclear engineering, where there are critical problems which must be resolved and where the more conservative procedure of build, test and extrapolate is either obviously prohibitive in time or cost or is dangerous.

In the past ECC has done much more work for companies in France and Germany than for similar companies in the United Kingdom. Three PACE machines are installed at their Brussels Centre, two of them each with 48 amplifiers and a third machine with 80 amplifiers. The machines may be interconnected for larger problems giving the possibility of using 48, 80, 96, 128 or 176 amplifiers. And, if necessary, the amplifiers in the electronic multipliers may be used separately giving a maximum of 216 amplifiers.

Rental is charged for each hour that a client's problem immobilizes the machine to any other problem, the normal working day being eight hours. The smaller machines are charged at 1,800 Belgian francs (£12 10s.) per hour and the larger at 3,000 Belgian francs (£21 10s.) per hour.

Engineering assistance is available at a cost of 360 Belgian francs (£2 10s.) per hour to help in whatever manner may be required: formulation, analysis, programming, preparation, verification, running of machine, evaluation of results.

Renting and Cost

The first step to renting is a preliminary discussion either at ECC or the customer's plant, or by correspondence for simpler problems. This allows the customer's engineers to outline the problem, define objectives and present available data. The applications engineers at ECC can then determine the most economical computing techniques, which may not necessarily lead to solution by analogue computer. Time and cost estimates can then be made. If required, a specialist applications engineer can formulate the mathematical description of the problem, evaluate available data and any assumptions. If necessary, he can request, carry out, or direct any research for more data.

Variables on the computer are represented by time, voltage, shaft position, etc. Having obtained correct and adequate equations to describe the system under study, suitable scale factors are chosen to provide maximum computing speed and accuracy, and the equations are transformed. A computer diagram is prepared showing the

interconnections of units in the machine. Settings of potentiometers, function generators, etc. are calculated, and tabulated. A verification procedure is worked out to show if there are any errors in the machine solution.

The interconnection of units is carried out by plugging wires into a demountable pre-patch panel. The panel is then mounted in the machine, the various units adjusted as necessary, the verification procedure carried out and any corrections or modifications made. The programme of runs may then be carried out either as prescribed or as directed by the client.

A discussion at the end of a session of computation is held to review progress and to decide if the prepared pre-patch panel should be preserved intact for further work or checks on the same problem at a later date. Applications engineers will assist in the interpretation of results and preparation of reports if required.

Clients may carry out their work entirely alone if they wish, merely reserving a certain amount of equipment for a certain time. Equally, ECC will receive, examine and solve problems entirely by correspondence and telephone. However, neither of these procedures is desirable.

Maximum efficiency and minimum cost to the client is attained when, as is the case for 80-90 per cent of the problems, a team is set up between the problem originators of the client and the applications engineers of ECC. The computation centres of EAI have developed powerful, simple and direct procedures without redundancies for using analogue computers. The client gets the full benefit of them, can see them in action, appreciate and learn them. Once the problem is on the machine, the client can concentrate on it without being distracted by the necessity of operating the machine—simple as operation is. Since results are produced graphically, he can assimilate them as they are produced. Without necessarily knowing anything about analogue computation, he can make necessary or appropriate changes in programme, thus obtaining the most valuable information at minimum cost.

In general, analogue computers are limited in accuracy while, for certain jobs, digital computers are limited in speed. Typical modern analogue machines, such as PACE, have an accuracy of 0.01 per cent for linear operations. Work is of course in hand to improve both types of machine in these respects. In particular one may mention the digital differential analyzer (DDA) which is a digital machine with simplified programming, approximating to that of an analogue machine.

There are certain regions where the superiority of each type of machine is clearly marked. The analogue computer is most suited to the solution of all types of differential equations, and any other type of problem must generally be transformed to a differential equation form in order to be studied satisfactorily. The digital machine essentially performs positional arithmetical operations and requires an adequate memory, or memories, to store instructions, figures for processing, and various answers. It is particularly suitable where very high accuracy is essential for data processing and for the evaluation of large matrices.

One could say that the digital machine can solve most problems that are solvable by the analogue machine. However, if the analogue machine can solve a problem at all, it can do it quickly and economically. The average time of solution of a problem, almost irrespective of size is approximately one minute. Most problems in engineering and applied science involve differential equations, often time-dependent. These problems are essentially analogue in nature and to investigate them by digital methods is slow, clumsy and prohibitively expensive.

Initially, medium to large machines were confined almost entirely to aircraft and guided weapon problems. Now many process control problems are being studied. These often involve the solution of partial differential equations, usually by finite difference methods, and require the use of large machines. Typical of such problems in the nuclear energy field are studies of reactor stability and control, heat exchangers, etc., and, in the chemical engineering field, studies of blending, distillation, etc.

The three computation centres of EAI have also studied problems covering many aspects of automobile, marine, mechanical, electronic, heavy electrical and oil reservoir engineering as well as pure mathematics and economics.

The function of an amplifier in an analogue computer is to take an input signal—expressed usually as a current or a voltage—and to produce a considerably greater current or voltage at the output terminal.

A bank of analogue machines and control units at the Brussels centre. The centre's staff, with Dr. Murphy operating a machine, busy on a client's problem.

In the field of economics, studies have included the simulation of economic systems, computation of business decisions, scheduling, and control of power systems, probability-distribution generation for operations research, linear and non-linear programming, etc.

Specific problems range from the design of small power tools and studies of vibration in domestic washing machines to studies of nuclear-powered submarines and the start-up and control of entire nuclear power plants.

The principal advantages to a client of rental of an analogue computer so far as our own experience goes are:—

(a) Availability of specialized capital equipment at low cost chargeable as running cost.

(b) Rapid and economical resolution of difficult or urgent technical problems.

(c) Availability of up-to-date specialist advice and assistance in a relatively new field.

(d) Training and appreciation of personnel in a new field, where personnel already trained are scarce.

(e) Ability to estimate realistically the value of an analogue computer to a particular company.

(f) Appreciation of just what quantity and type of analogue computation equipment would be justified for a particular company should one decide to buy.

(g) For the small company without a research and development group, the availability of a comprehensive consulting service for dealing with special technical problems.

British Firm Points Way to Integrated ADP

BY ROBERT McKINNON

Integrated Data Processing is still the dream of many computer users in commerce and industry. But here is a bold and promising pioneer attempt.

ONE of the most obvious ways of getting full value from a computer installation is to use it for integrating stock and production control, but this is something about which industry still knows very little. For this reason the pilot scheme which has now been in operation six months at the Letchworth plant of International Computers and Tabulators Limited (I.C.T.) is of much interest and importance.

Here, in brief, the company is using one of its own computers (a *Hec 1201*) to control—at one and the same time—production, plant loading and stock levels at a satellite plant, Factory 1B. About 500 people are employed in this plant in the manufacture of electrical components such as cables, coils, relays, brushes, control panels and plugwires. In all about 700 different assembled end products are made, plus a further 500 piece parts for supply to other company factories. It is also the company's 'guinea pig' factory for they plan to extend the system, if successful, to other factories in the group. And experience to date has borne out that refinements but no major alterations have been necessary.

The 1B scheme took two years to prepare, beginning in the summer of 1956 when a steering committee got down to a year's investigation of the project. After that, a research team of six was formed to carry on the more detailed planning of the work. It consisted of a team leader, who was a practical engineer, a senior and junior systems engineer, an administrative officer and two computer programmes. The important thing about this team, the company stress, was that members knew each other's jobs. Their investigations lasted from October 1957 to August 1958 when the system was introduced. Now, one girl operates the computer on day-to-day processing work while the system proper continues to be studied and refined by the team. The next step will be to apply it to the major (No. 1) factory at Letchworth where the company's tabulators are made.

So much for the origins of the scheme. Before describing the system in detail, however, it is worth mentioning briefly the company's thinking on the matter. Production control is of course one facet of management control, but in the opinion of I.C.T. there is today a much wider concept of what constitutes production control. The old piecemeal approach is outmoded and the need to recognise

Nerve centre of the Letchworth project! The computer control centre at Factory 1B which is regarded as an integral part of the company's punched card system.

the critical inter-relation between all the factors involved in efficient manufacturing and sales is stressed.

However, the problem of obtaining up-to-date facts and figures needed for decision and policy remains. And it is here that a digital computer comes, as it were, into its own, for it provides facts and not history. By manual methods, the time needed to publish the detailed production programme and to monitor it through all its stages imposes a lengthy production cycle and prohibits amendment at short notice—especially when the thousands of parts which are so often compressed into a single product are taken into account. Therefore, to use the company's own metaphor 'any system which renders the vessel more readily answerable to the helm, more immediately responsive to the orders from the bridge, is of incalculable value.'

That is why the company believes that what they have evolved at Factory 1B is basically a new *philosophy of management* whose advantages, they hope, will be recognized and in time adopted by other British manufacturers.

The computer control system in 1B factory can be described as an example of 'integrated data processing within limits.' This is because costs and accounts are not integrated with the system. It involves two distinct operations: planning and control. More specifically, these may be described as:

Programme breakdown—needed for the translation of a sales programme of end product requirements into a production plan for their manufacture;

Plant loading—to determine the total load per machine group available in each manufacturing period and to allocate time of specific machines and groups for carrying out specific operations;

Progress control—to compare actual and projected performance and to adjust discrepancies between them; and

Stock control—to ensure that raw materials and piece parts are available at the times and in the quantities needed, *at minimum inventory cost*.

Now let us examine the system in more detail. It incorporates five main factors as follows:—

1—Analysis of requirements;

2—The provisioning of materials to meet these requirements;

3—Comparision of requirements with plant capacity;

4—Issuing of works instructions; and

5—Comparison between production planning and the actual activity on the shop floor.

The first step is to draw up the production programme *without reference to the computer* but from the regular sales forecasts and irregular input of demands from the Spares and the Development Departments.

The next step is to expand this programme (which at this point is expressed in time periods and end products required) into a programme of parts in the corresponding time periods.

It is at this point that the computer comes into the picture with Hollerith 80-column punched cards being used as input and output. What actually happens is that each end-product assembly is expressed as a parts list which is then converted on to punched cards. In this way the end-product demand is converted to a parts demand. (This parts list, by the way, forms one of the three main punched card libraries which have been built up through the operation of the scheme. The other two libraries cover the data conversion programme and plant capacity. These libraries do vary but only very slowly.)

This job makes up the first computer run.

It is worth noting too, that this 'explosion' of assemblies into parts used to take 5½ weeks with ordinary punched card equipment; now the computer does it in a matter of a few hours.

The next step is a sorting operation and it is done by a punched card sorter, not by the computer. It consists of dividing the programme of parts yielded by the first computer run into 'categories of parts.' These categories are as follows:—

1—Parts to be bought as finished parts from suppliers;

2—Parts to be supplied from other factories within the I.C.T. group.

3—Parts to be sub-contracted; and

4—Parts to be made within 1B factory.

Where the first three categories are concerned, the purchasing agent, the sub-contract department and the stock control section take the necessary action to ensure that parts will be available as needed.

In terms of parts and categories, the production programme for 1B factory is now very explicit, so the next step is to convert these requirements to work load in terms of hours and compare this load with the capacity of the plant.

This makes up the second computer run.

If the demand is greater than the capacity of any group of machines or assemblies, the computer prints out those areas that are overloaded together with the amount of the overload. The same applies to underload. Under the old system any such over- or underloading would not have been known.

This Over-all Loading Assessment, as it is called, takes 2½ hours of computer time, and a point worth noting here is that there is no preparation time needed for the second computer run. This is because the cards for this run are output from the first computer run, while the data conversion and capacity cards are already available from the card library.

It is at this point too that the Production Controller has to make his first decision, and the system gives him a picture of the situation up to 21 months ahead. The type of decision involved might be whether, if there is a capacity overload, to introduce overtime or double shift working; similarly, if there is an underload, the controller would have to decide whether to bring work forward or to transfer people to other jobs.

The next step, however, looks only 20 weeks ahead and moves from categories of parts to batches. In this operation, the new monthly orders supersede but incorporate the information from the old provisioning arrangements. It is therefore necessary for the computer to keep constantly up-to-date with the movements of parts in and out of stores. Hence, a daily updating routine is also necessary.

This is the job of the third computer run which lasts about one hour each day.

Here again this was not done under the old system, but even more important is the revolutionary concept of stock control involved. *What, in brief, it amounts to is that the company is no longer working with uncontrolled stock, for it is possible to put a checkpoint in the programme here whereby the computer can detect any documentation error.* This does away with any need to hold inquests over stocks. The really important point here is that I.C.T. are scanning and balancing its stock for a full 20 weeks *ahead*, and

This Data Processing Scheme

Took two years to plan

Is an integrated system except for costs

Allows for *management by exception*

Simplifies the task of decision-making

Looks as far as 21 months ahead

Means a better service to customers

Produces more timely and accurate information for management

that output is of 'exceptions' — only those items requiring attention.

The next step is to take the batch requirements and refine these in terms of plant capacity, so that the longest operations are loaded first and so on. Here, the computer is in fact doing a kind of jigsaw puzzle, with output again a list of over- or under-capacity but this time in much more detail. It also prints a 'computer operation job card' which says when each operation on each batch of work should be started and finished.

This is the fourth computer run and completes the planning side of the picture.

We now come to the control side, and the next activity after the fourth computer run is to make sure that the shop floor *can* do what is asked of it. As a first step, the necessary tools, materials and authority to do the work are supplied and each foreman is given every week a list of operations required for the next fortnight. The first week is made up of jobs with a definite priority and the second of jobs with a rough priority on which the foreman can use his discretion. Meanwhile the various stores are advised of what will be wanted one week before the actual requirements. All this is listed in plain language.

The next step is to reproduce the computer operation job card in various forms to meet the needs of orthodox works documentation. These documents are produced by the punched card reproducer and comprise: a batch identity card, a raw material or piece part requisition, a drawing requisition, a central control operation job card, a factory operation job card, and a time card.

One copy of the factory operation job card goes to Central Control and the other to the foreman concerned. The foreman's card is mark sensed after the job has been inspected and sent back to Central Control where it is compared with their own card which gives the original planned quantity and completion date. Any discrepancy in quantities is fed into the daily manufacturing control routine which, as already mentioned, is taken care of by the third computer run.

In addition, every week the foreman's weekly work schedule is compared with the jobs actually completed in that week. This forms the basis of progress investigation within the works and the management's effort is therefore limited to areas where things have gone wrong. This is in fact a first-rate example of the much-talked-of concept of 'management by exception,' and in this case it is obvious how a great deal of unnecessary work has been cut out because of the accuracy made possible by a computer.

When assessing the benefits to the company of this scheme, it should be borne in mind that it has only been in operation some six months and as yet extends only to part of the I.C.T. production at Letchworth. Even so, the positive results so far achieved point unmistakably to what was originally hoped for.

1—Quicker response to varying sales demands, hence a better service to customers;

2—A much more rapid production programme changeover than had previously been possible;

3—The reduction of production time—within cycle time—to a realistic minimum; and

4—The production of more accurate and more timely management information, much of it—notably illuminating comparisons—available for the first time. One effect of this has been a review of the volume and deployment of sub-contracting commitments.

Last but not least, has been the encouraging reaction to computer control among the work-people themselves, especially among the foremen. In some sections productivity and bonus have increased and housekeeping is much better, but most important is that work groups now feel confident of the figures to which they are working and this is reflected in a more purposeful application to the job on hand.

Not every ADP job needs a computer. At Vauxhall Motors, for instance, two electronic calculators more than cope with a huge spare parts stock control job.

A Calculator Controls 32,000 Different Spares

by JOHN STACEY

NOWADAYS, the electronic calculator is often thought of as a kind of poor relation or " rude forefather " to the digital computer. In an engineering sense, this may well be true, but it is also true that the calculator can still form the nucleus of a very worth-while ADP system and can indeed do many jobs just as efficiently and more economically than its more sophisticated descendant.

One excellent example is the stock control system at the Dunstable factory of Vauxhall Motors Ltd. where two IBM 604 electronic calculators backed by four IBM 421 accounting machines are handling a stock control job vital to the servicing of roughly one million Bedford and Vauxhall vehicles in different parts of the world.

The volume of work involved in this job has increased by 10 per cent each year since the end of the war and currently covers some 32,000 different spare parts. These are supplied through something like a thousand dealers in the United Kingdom, while abroad there are 18 assembly plants supported by their own dealers and a further 150 distributors, again supported by their own dealers. Yet despite this constantly growing volume of work, Vauxhall today employs fewer staff in the clerical functions of stock control than ever before, and the records of all spare parts are kept entirely on punched cards.

The stock control system works as follows. Each main dealer submits a monthly stock replenishment order and, if necessary, supplementary orders to keep his inventory at the desired level. Emergency orders for items not held locally can be placed on the factory. To meet these various orders the Distribution Division of the Parts and Accessories Department has to prepare some 900 invoices representing something up to 20,000 item lines each day.

Further, the company must ensure that: —

- a very wide range of parts and accessories, covering both current and older models, is held in stock in their Parts Warehouse;
- a range of parts to cover most of user requirements is available at local dealers; and
- parts not normally held by local dealers can

Part of the large IBM installation at Vauxhall Motors Ltd., where stores control is one of the main applications.

be supplied promptly from the Dunstable Warehouse.

When orders are received, the following processing steps come into operation: —

1. Order items are processed to determine stock availability.
2. Selection and dispatch documents are prepared in Bin Location order.
3. Invoices are printed in Part No. order.
4. Invoices are posted to the Sales Ledger.
5. Statistical analyses are produced.

An IBM punched card installation now based as stated on two electronic calculators and four accounting machines, began work in 1954-55, and was originally responsible for the preparation of dispatch documents and invoices only. By the beginning of 1959 progress was such that all these five steps had been mechanised.

Stock and supplementary orders are processed in the four days following receipt, dispatch of goods taking place on the third and fourth day. In the case of export orders, invoicing is postponed until packing of the goods is completed.

The normal four-day cycle is as follows: —

Day I. Punched cards are prepared representing each line of the orders.

Day II. Stock availability is calculated and stock records are up-dated.

Day III. Dispatch notes are prepared.

Day IV. Invoices are printed.

The work of these four days is now described in detail.

Day I. From each line of the order the part number and quantity are punched into an IBM card and the cards of each order also have common information (such as order number, date and dealer code), gang punched into them. Receipt cards and stock adjustment cards are punched with the requisite movement details. All these cards are then sorted into groups by part number order, so that each group might consist of Receipt Cards, Adjustment Plus or Minus Cards and Issue Cards.

Day II. The cards from Day I are merged auto-

matically with the Master Stock Balance File. The Balance cards for which there are no corresponding movement cards are rejected, and blank cards are inserted behind the remaining part number groups to act as new balance cards. The complete file is passed through the IBM 604 electronic calculator, which, in a single run: —

- calculates the new stock balance:
- calculates the new movement:
- works out the new usage, distinguishing between domestic, export and special usage:
- analyses stock status; i.e. a change from 'in stock' to 'out of stock' or vice versa is indicated by a code punched in the new balance card:
- indicates if the new stock balances have fallen below re-order level:
- compares the quantity ordered on each issue card with the stock balance and indicates on the issue card whether the stock is wholly, partly or not available, as well as the quantities to be shipped and 'pended' (back ordered):
- gang-punches information common to all cards in each group (i.e. bin location, price, etc.), from the old balance cards into all following cards and checks its own calculations.

When the cards have completed their passage through the IBM 604, they are sorted into their different categories. Old stock balance, receipt and adjustment cards are filed for reference. Issue cards are passed to the next day's operations, and new balance cards are sorted further into the following groups: —

a. Parts below re-order level.
b. Parts now out of stock.
c. Parts now in stock.
d. Parts with no change in status.

The first three groups are listed on an accounting machine and then the entire file of new balance cards is merged back with the file of no movement balance cards in readiness for the next day's processing.

Day III. Issue cards are sorted by dealer and then into bin location order and status, i.e. fully shipped, part shipped or 'pended.' Dispatch notes are printed advising the Stores Department of the part numbers required and their location. A copy of the dispatch note is printed on perforated cardboard and each strip, when detached, is tied to the actual item as a label.

'Pended' cards are passed to a manual section which scrutinises the receipts until the item is again in stock, whereupon the card is returned to the IBM Section for processing.

Day IV. Issue cards are sorted to part number order within dealer orders and are passed through the IBM 604. Price is multiplied by quantity and a gross price is punched. Discount is accumulated and punched into a trailer card. From these cards the invoices are then printed on the IBM 421 accounting machine. The discount trailer cards are used for postings to the Sales Ledger. Export orders are invoiced after packing and dispatch as the invoice must conform to the Customs regulations of the importing country and show such details as the case number.

Emergency orders are dealt with at once. The dispatch note is produced prior to the normal stock balance run on the IBM 604. If an item is subsequently found to be out of stock, the entry is reversed. As a safeguard, however, against issuing demands for out of stock items, and in order to complete details of description and price, a master file is kept containing such information and stating whether an item is in or out of stock. This file is kept up to date by using the daily listing of alterations in stock status.

Prior to the installation of ADP equipment, the system used was entirely manual, and invoices were typed. During the first two years after installation, demands on the stores and invoices were printed on IBM accounting machines, but, when orders came in, there was still the lengthy process whereby a clerical section numbering 28 entered stock availability instructions on each line of each order and also posted the stock record cards. The orders were then sent to the IBM Section, where pre-punched cards were drawn from a tub-file for each item on order, and into these cards the quantity to be shipped was punched.

The present system has made it possible to dispense with the clerical section and also the tub-files, which, at peak periods, proved to be a serious bottle-neck. Moreover, the present system could, without an increase in staff, deal with up to 25,000 lines of invoicing a day before more powerful equipment would be needed.

Not only does this equipment allow Vauxhall Motors Ltd. to meet the ever-increasing volume of work, but it has also brought a more positive and accurate control of stock, removing from this routine, but important, work the errors which are necessarily inherent in any manual system.

English Electric employ some 30 programmers at their Strand computer centre—both for their own and for clients' work.

At Your Service—250,000 Hours of Programming Experience

by PHILIP MARCHAND

Firms starting out on ADP can get a lot of help from the computer centres run by the manufacturers. To illustrate this, Automatic Data Processing is publishing a series of articles. The first looks at English Electric's centre, Marconi House, The Strand.

WHEN in March, 1956, a *Deuce Mark I* machine was put in the shop window of English Electric's Strand headquarters, a second computer centre, to maintain contact with the range of computer activity then growing in London, was established to offer computer-time to firms in the London area, and also to demonstrate the *Deuce* machine to prospective customers and users.

One point that English Electric make about their London centre is that it is only half of a service, the other half being the company's centre in Stafford.

In Stafford, English Electric first used their own computers for a variety of company work—con-

Men Behind the Service

G. M. Davis (left) took a degree in Mathematics at Cambridge and worked on Radar design during the War. He joined the English Electric computer study contract team at N.P.L. in October, 1950, and since then has worked on most aspects of computer application, design and operation. He was responsible for setting up and establishing the company's London Computing Service and after a period in charge of it, is now returning towards his former interests in computer design.

Dr. V. E. Price carried out research in theoretical chemistry using EDSAC 1 at Cambridge when it first came into operation in 1949. In January 1955, he joined the English Electric team at N.P.L. which was the nucleus of the present London Computing Service, and has been generally responsible for its work on scientific and engineering design calculations. He has recently taken charge of the centre in the Strand.

nected with design and other engineering problems—and then, with the experience they gained, began doing similar work for outside firms on a time-hire basis. This in fact is still the pattern at both centres: company and outside work is done both at Stafford, and on one machine in the Strand, although the company employ three further computers wholly for company work and are installing at least two more.

What is being done

At present about fifty firms use the London centre, and this represents about half of the computer work that is being carried out here. Some firms use the centre regularly for recurring problems, others for one-off jobs that are quickly completed on a computer.

The type of work also varies. A good deal of it, following the company's own bias, is connected with engineering design,—for example calculations on the stresses that piping can take. On the other hand work connected with stock and production control, market research, transport and work scheduling and actuarial calculations has also been successfully tackled.

Statistical analysis work is being handled too. One example of this is the job being done for a chemical process plant, where data referring to plant conditions, such as temperatures, pressures and rates of flow, and to the settings of control knobs and levers, are processed. The computer provides accurate analyses of the effect that the use of controls have on plant conditions, and the results (what really happens when a button is pressed) can then be used to give more complete control of plant conditions.

What the service offers

On the average the centre receives about one enquiry a week—excluding enquiries that are ' totally unrealistic ' or those that have already been weeded out by the other departments of the company.

Unless a customer comes to the centre with a programme already written for a *Deuce* machine, the centre has to get to grips with the customer's problem. There are generally three main steps involved:

—a preliminary discussion with the customer to find out what is required and how the work could be done.

—a detailed analysis of the problem by English Electric's or the client's staff, or by both, possibly involving further meetings.

—finally the detailed programming and programme testing, which again may be done by

English Electric or by the client-firm. The balance and length of the various stages varies widely from problem to problem.

Sometimes however the job consists of a completely standard operation such as solving a set of simultaneous equations, for which a library programme is used and no analysis or programming is needed.

About half of the firms that use the service leave or have left the job of programming to the centre which employs a staff of thirty to handle this work.

Other firms either already employ programmers trained on computers other than *Deuce* or send their people to a three-week programming course in Stafford. (The course costs £40 and, actually takes four weeks to complete as the students are dismissed after a week to go away to think about what they have learned.) The centre provides desk space for the use of customers' programming staffs, and of course puts at their disposal card-punchers, sorters, printers, etc. to prepare cards—which are the input and output medium of the machine—as well as programme library facilities and operating staff.

A number of automatic programming schemes for *Deuce* are available to the centre's customers. (Some have been developed by English Electric—for instance, Alphacode—and some by other *Deuce* users—the GIP code by the National Physical Laboratory and TIP by Bristol Engines.)

These automatic programmes present customers with two advantages:

1—they can be used for 'trial runs' before writing a detailed *Deuce* programme to establish whether the numerical techniques a programmer proposes to use are the correct ones for the job he wants to do.

2—they can save a great deal of programming effort, as they are 'prefabricated' programmes. The *Deuce* Alphacode for example can be picked up in a day ot two, and of course cuts out the need to write a detailed programme. As the time taken in preparatory work—systems study, programming, etc.—before a problem can be put on a computer must in some cases be reckoned in months (as against the relatively short period of actual computer running time) making use of automatic programmes can produce considerable savings. Usually this will more than compensate for the slower working speeds on the machine—additional time must be allowed for code translation—that automatic programmes take when compared to specifically written programmes. Automatic programmes are particularly useful for one-off jobs.

Another important service available to customers of the centre is access to the library of written programmes and sub-routines which are freely at the disposal of all *Deuce* users. This library represents more than a quarter of a million hours of programming work and covers a very wide variety of calculations carried out in the field of scientific research, mathematical engineering and commercial and industrial applications.

When, as occasionally happens, an organization comes to the centre with a problem and the centre see that 'computerwise' the study of another company's programme would be helpful, English Electric sometimes suggest that the company be approached for permission to use it. In this way the centre's customers can sometimes also benefit from the experience of other companies. In such cases, however, care is taken that commercial security as between the centre's clients is maintained.

Stability of Earth Dams ensured

Calculation Costs Cut by 97%

One regular job carried out by the centre is for Binnie, Deacon and Gourlay, consulting civil engineers. Analysis is made from design data of the stability of proposed earth dams in various parts of the world. The consultants have to ensure that their dams will be strong enough to resist both weight of earth in the dam, and pressure of water — and for this it is necessary to calculate a factor of safety for each of a number of surfaces along which it is thought that slipping might occur.

Mathematical equations for finding the factors of safety for 'circular slip' surfaces had been formulated by Dr. A. W. Bishop of Imperial College, London, and the centre worked out a suitable numerial technique for solving the equations and wrote a programme for the job. A form-layout to take the data describing a dam and specifying which 'circles' were to be analysed was devised in consultations between the company and the centre. This had to be suitable for filling in by the engineers dealing with the dams, and also for the people who had to punch data in cards.

Formerly, these calculations were done by engineers by hand, and to obtain reliable results one person usually analysed only about two circles a day. On the *Deuce* machine, after an initial period of about two minutes to assimilate instructions and data, calculations about each circle are completed in about six seconds. Previously the cost of doing these calculations by hand was about £4 a circle, whereas now the cost is about 2s. a time.

Computing work is centred round a Deuce Mark I machine which uses punched cards for input and output.

Another source of programming experience for the centre's customers is through *Deuce News*, a broadsheet publication sent out to all companies who have installed their own *Deuce* computers or who use one of the centres. This broadsheet gives lists of programmes added to the *Deuce* library, covers new programming techniques and work in progress on all *Deuce* installations, and so can save considerable duplication of effort.

What it costs you

The centre charges customers a fee of £30 an hour for computer time when the outside firm do their own programming, and up to £60 an hour when the centre is asked to do it. If the centre is required to do a complete job—system studies, programming, and running the machine—and this may take a great deal of time, then a contract is normally drawn up in lieu of the fixed charges.

English Electric's centres are not run on a commercial basis to earn large profits. In fact the company are content if the centres break about even. The real value of the centres from the company's viewpoints lies in:

1—acquainting small and large organizations with computers by giving them the chance to use one.

2—the 'know-how' the company itself gains by applying all kinds of new problems to its own machines.

English Electric's first applications for their own computers were mostly engineering applications, connected with work on, for example, ballistic missiles, aircraft and transformer design. The centres have given the company a wider all-round knowledge of what their machines can be made to do.

The London centre has not yet been given a large commercial data processing job to do, and would probably not be keen to tackle anything very big in this line on a service basis. They are, however, running one or two smaller jobs successfully and are interested in obtaining further valuable experience in this field.

All part of the service. The centre's staff gives advice to customers on the best way to put problems on to a computer.

New Test Equipment—A transistor tester capable of checking the performance of transistors while they are connected within their circuits. Manufactured by the Philco Corporation, commercial models of this equipment will be available in the near future.

New ADP Systems Do Several Jobs at Same Time

Monthly feature prepared by New York office of John Diebold and Associates

A NEW generation of computers has been introduced in the United States. The significant advances in logical design will enable greater efficiency of automatic data processing operations. Some of the new features include:

- Ability to control several independent programmes at one time.
- Simultaneous reading and writing operations on multiple magnetic tape units.
- Independent search and copy operations on magnetic tapes.
- Simultaneous card reading and punching and printing operations.
- Input-output operations simultaneous with internal arithmetic and logical operations.
- Reduced physical requirements as a result of transistorized circuitry.
- High speed internal operation.

The potential for efficient and economical use of the hardware is provided by these features. Maximum efficiency is obtained when a system is well balanced. Input and output speeds do not compare to the microsecond speeds of internal computation. Therefore, as the number of simultaneous input-output operations increases, the greater the efficiency of the system.

Some of these new computers have gone a step

further. Not only can peripheral and internal operations be performed at the same time, but the control section of the computer can direct the processing of several different jobs at one time.

More Balance and Economy

It is this time sharing ability that leads to a more balanced system and more economical data processing. Physically, the use of transistors has enabled reduction of computer manufacturing costs as well as expected reductions in site preparation, maintenance and operating costs. The reasons for these reductions are found in the nature of the transistor. It is smaller than a vacuum tube. It dissipates very little heat, requires less power and has proved to be extremely reliable. The transistors are partly responsible for the increase in operation speeds but the significant factor of over-all efficiency is found in the sophistication of logical design.

There has been a constant stream of announcements of new computers during the past year. Most of these fall into a class which ranges from the medium to large scale computer groups as we know them today. The specifications of these systems are shown in the accompanying table. The modular design of these systems gives the user his choice in the configuration of equipment for his installation. In order to provide a means of comparing costs an average system rental is shown. In all cases this system is composed of the data processor, the minimum core storage unit, a card input, printer and six magnetic tape units, all with the necessary controls. Minimum systems will, of course, rent for less and larger systems can be built up to considerably higher rentals. All of these machines may be purchased, if desired.

The first of these computers to be announced and installed is the *Transac S-2000* manufactured by the Philco Corporation of Philadelphia. The two *Transac* computers currently operating are being used for scientific applications; magnetic tape units are to be delivered to one of these installations in the next few months. Shortly after the *Transac* announcement, National Cash Register Company came out with their transistorized *304 Data Processing System*. The first production model of this equipment is expected to be delivered to the U.S. Marine Corps. in July of this year.

In the latter part of 1958 *IBM's 7070* and *RCA's 501* transistorized systems were announced. With four systems now on the market, it became clear that the transistor design was to be the new era in data processing systems.

The most recent announcement came from Minneapolis - Honeywell Regulator Company, manufacturers of the large scale *Datamatic 1000*. Their new computer is called the *Honeywell 800*. The system has some of the most impressive time sharing features existing today.

In addition to the medium to large scale machines, transistorized computers are available at each end of the scale. Remington Rand has introduced a small scale card computer system called the *New Univac Computer*. IBM has announced the large scale *7090* as the most powerful data processing system to be marketed commercially by IBM.

Continental Interest

Remington's machine has been marketed in Europe for some time; a working installation at the Dresdner Bank in Hamburg, Germany, is performing a wide range of bank functions. They now hold several orders for deliveries on the Continent. Deliveries in the United States will begin in June of 1959, renting at $6,950 a month with a purchase price of $347,500. This seems to be a very powerful machine for the price. Card input and output can proceed simultaneously with internal computing. The printer operates at 600 lines per minute. An internal magnetic core storage capacity of 50,000 characters is provided. Programming has been simplified, through the use of a new system known as Flow-Matic coding. This uses ordinary English words and phrases instead of mathematical symbols. Operating management such as accountants and systems and methods people can prepare their own programmes, leaving only the final details to a coder.

At the opposite extreme in size, IBM's *7090* is in a high cost bracket: Rental per month, $64,000; purchase price $2,880,000. Sylvania Electric Products, Inc. is scheduled to receive the first machine next November.

Some interesting facts concerning the *7090*:

- performs 210,000 additions or subtractions per second.
- magnetic core storage capacity for 32,000 ten digit numbers.
- access time to core storage: 2.4 microseconds.
- maximum system: 80 magnetic tape units, eight card readers, eight printers and eight card punches.

Characteristics of New American Computers

Name of System	Honeywell 800	IBM 7070	NCR 304	Philco Transac S-2000	RCA 501
Approximate Rental per Month for an average system	$22,300	$19.450	$20,200	$29,500	$14,675
Expected initial deliveries in U.S.	1960-4th quarter	1960-2nd quarter	1959-3rd quarter	2 systems: 1958 Tape Units: 1959 1st quarter	1959-2nd quarter
Availability in United Kingdom		Full staff of sales and maintenance personnel: delivery schedule same as U.S.	Not available outside U.S. at the present time	European marketing programme under study at present time	Available but limited sales effort at present
Internal magnetic core storage capacity	4,096-16,384 words Word: 48 binary digits or 11 decimal digits. Access: 6 microseconds per word	5,000-10,000 words. Word: 10 decimal digits plus sign. Access: 6 microseconds per word	2,400-4,800 words. Word: 10 characters Access: 60 microseconds per word	4,096-65,536 words. Word: 48 binary digits equivalent to 15 decimal digits. Access: 10 microseconds per word	16,384-262,144 characters. Word: variable length. Access: 45 microseconds for 12 characters
Auxiliary Storage	Magnetic tapes: Tape units, maximum: 64. Capacity per reel: 20,000,000 decimal digits. Transfer rate: 90,000 characters per second	Magnetic tapes: Tape units, maximum: 12. Capacity per reel: 5,760,000 or 15,379,200 characters. Transfer rate; 15,000 or 62,500 characters per second	Magnetic tapes: Tape units, maximum: 64. Capacity per reel: 5,700,000 characters. Transfer rate: 30,000 characters per second	Magnetic tapes: Tape units, maximum: 256. Capacity per reel: 16,000,000 characters. Transfer rate: 90,000 characters per second	Magnetic tapes: Tape units, maximum: 63. Capacity per reel: 9,000,000 characters. Transfer rate: 33,333 characters per second
	Magnetic Drums: No specifications at present	Magnetic Disc Units: Units, maximum: 4. Capacity per unit: 6,000,000 digits		Magnetic Drums: Units, maximum: 256. Capacity per unit: 32,768 words	Magnetic Drums: Units, maximum: 32. Capacity per unit: 1,500,000 characters
Input Punched Card Readers	240 or 750, 80-column cards per minute	500 80-column cards per minute	1,500 80-column cards per minute	2,000 80-column card per minute	*Off-line only:* 400 80-column cards per minute
Paper Tape Readers	No specifications at present	None at present	1,800 characters per second	1,000 characters per second	400 characters per second
Output Card Punches	100 or 200 80-column cards per minute	250 80-column cards per minute	No specifications at present	100 80-column cards per minute	*Off-line only:* 100 80-column cards per minute
Paper Tape Punches	No specifications at present	None at present	60 characters per second	60 characters per second	10 characters per second
Printers	150 and 600 lines per minute: on-line	150 lines per minute: on-line	600 lines per minute: on or off-line	800 lines per minute: on or off-line	600 lines per minute: on or off-line

▶ eight input-output channels provided for simultaneous operations.

Three areas of the physical requirements for a computer installation are expected to be reduced with transistorized machines; space, air conditioning and power. Of these three, reduction in the over-all space requirements is probably the least significant. Most of the medium-to-large-scale equipment manufacturers are quoting approximately 1,000 sq.ft. for an average system. RCA is above at 1,600 sq.ft. while the average Honeywell System can be accommodated in 500 sq.ft. There are several reasons why space requirements can be reduced with transistorized machines, but at the same time there are some requirements which cannot be reduced. Space is saved because:

▶ Transistor circuitry can be more compact than vacuum tube circuitry resulting in a reduction in the size of the units. This is only significant in the central computers and the control units.

▶ Lower heat dissipation of transistors and consequently less need for ventilation eliminate the need for space between units. For example, IBM's *7070* tape units may be located adjacent to each other whereas previous models could not.

▶ In the case of the *Honeywell 800*, the central computer unit may be located against a wall.

Space requirements remain constant because:

▶ Sufficient space for operating personnel is necessary.

▶ Space for access to maintenance panels is required. Although more efficient maintenance panels have been designed, there must be room for the engineer and his test equipment.

▶ The size of card machines, printers and magnetic tape units are not substantially reduced because the mechanical components are not affected by transistors.

The second area of physical requirements which can be reduced with transistorized machines is the

air conditioning. With the elimination of vacuum tubes a reduction in heat dissipation of approximately one-half has been realized. Whereas an IBM *705-III*—one of the more recent vacuum tube computers—will dissipate 160,000 BTU/hr., the new *7070* dissipates 76,000 BTU/hr. for the same configuration of equipment.

As a result of the reduced heat dissipation of the units, air conditioning requirements are less. Philco Corporation is recommending 5 tons for their average system. On the other hand, IBM is recommending approximately 9 tons for their tape *7070* and up to about 16.5 tons for a *7070* system including random access disk files. These, nevertheless, show substantial reductions when compared to the *Burroughs 220*—a vacuum tube computer in this same class. Its air conditioning requirement is more than 20 tons for a comparable system.

In addition to heat dissipation reduction, the power requirements of the transistorized systems are significantly reduced. Using the Burroughs *220* for comparison again, its average system will use approximately 75 kW. A Philco *Transac* operates on less than 15 kW. Other transistorized computer power requirements will range up to 30 kW. It is interesting to note that one of the first computers produced—Remington Rand's *Univac I*—requires about 120 kW. for a system with comparable configuration.

Better Reliability

Although considerable savings are realized from the above mentioned transistor features, one of the most important of their assets is the expected high degree of reliability. We say 'expected' because these transistors have not been in use in a going installation for a long enough period to determine their true performance. According to tests which have been run, these units have been quoted as ten times as reliable as the vacuum tubes they are replacing. Since the transistors do not burn out, it is conceivable that a fully transistorized computer unit may operate for as long as a year without attention.

This increased reliability leads to a reduction in maintenance costs. In the first place, less replacement of parts will be necessary. With more reliable components there should be fewer occurrences of machine failures.

This will afford a savings in the time of maintenance personnel. While the transistors themselves provide benefits, the new computers have been designed with ease of maintenance in mind. An effort has been made to provide access to all test circuits on compact maintenance panels. Some of the manufacturers have designed new test equipment to make the maintenance operations more efficient. All of these facts indicate that maintenance problems will be reduced.

However, at this point there are not enough systems operating to determine actual cost figures on operation. As these new computers are installed and build up a history outside the laboratory, their performance can be judged realistically. In the near future, facts and figures will be available which will show whether the new generation of computers can live up to the reputation which has been built up for them.

Better Design

Overshadowing the improvement in the physical design comes another forward step—an improvement in the logical design. The new design features provide a more even balance between high internal computing speeds and the input and output operations.

In the first place high internal speeds have been attained from the use of magnetic cores for storage, parallel transmission of data, and high speed switching circuitry. In order to produce an efficient system it became necessary to design input-output facilities which could make use of the computing capacity of the central unit. This is obtained in part by increased reading and writing speeds on the peripheral units, but mainly by more effective time-sharing operations.

Time-sharing

The most common time-sharing operation is the simultaneous operations of peripheral units reading in and out of buffers and internal computing. This feature is present in a number of computers in use today. However, some of these new computers have extended this type of operation a step further. Data which is being transferred in and out of smaller buffers is also going to and from the internal storage itself while the internal computation takes place. The ability to perform numerous simultaneous operations is attained through the sophisticated design of the control circuitry, not by duplicate circuits.

For instance, the *Honeywell 800* can control up to eight independent programmes simultaneously and also the operation of eight input units, eight

Remington Rand's New Univac Computer—A small-scale computer operating at microsecond internal speeds. The magnetic amplifier, solid state commercial data processing system was announced and shown in actual operation at the Eastern Joint Computer Conference this past December.

output units, eight tapes reading and eight tapes writing. As the eye sees the system, everything is going at once. Actually the control circuitry allows portions of data to be transferred alternately from each operating unit so that the computer may be operating at full speed. If one programme is waiting for input data, the control allows others to proceed until the detained programme is ready to proceed.

This is a very brief description of an intricate process, but it should indicate the degree of time sharing which is being realized in some of these computers. From the facts now available, the *Honeywell* seems to be the most advanced in this area. The IBM *7070* also shows good features for time sharing. It will be interesting to see how effectively these features will improve ADP operations.

The improvements in our new generation of computers should lead to more economical automatic data processing. The savings from reduction in physical requirements, a higher degree of reliability and the ability for more efficient use of the hardware provided are the factors involved. We are now sitting at the dividing line. We have been introduced to new ideas in data processing. We have been told what is possible. If we make the best use of the tools with which we are provided, then the aim of more economical operations should be realized. It will be interesting to see how productive the new generation of computers will actually be.

Order Your Equipment with an Eye to the Future

This is the first of a series which explains in simple terms the functions of various items in a computer installation. Mr. Helman begins with an assessment of the main factors to be taken into account before a purchase is made.

by A. L. HELMAN

I DOUBT whether any two data processing installations in this country or in the United States possess exactly the same equipment. This is not unreasonable, for naturally each company obtains equipment to suit its own particular problems.

It does not mean that each company has had a different ADP system designed specifically to suit itself; all manufacturers of computers try to make their equipment as flexible as possible, and most systems give a wide range of alternative input-output equipment, together with other variations, to allow for future expansion. Thus, the type of equipment required will depend solely on the particular applications of the company.

When considering both ADP equipment and applications, it is important to think in terms of the future rather than the present, since the time taken from the decision to install a computer to the actual installation will be of the order of two years. During this period the company's requirements may well change, and certainly in two years' time the recently announced solid state (transistorized) computers, which are capable of carrying out two jobs at once, will be well to the fore.

The largest and most expensive piece of equipment, in fact the centre of any ADP organization, will be an electronic computer. Essentially, a computer is a 'magic box' that can add, subtract, multiply and divide, and say 'yes' or 'no' to a small number of set questions, all at speeds far greater than the human mind can even visualise. In addition to these simple properties the computer is able to receive and return information in the form of numbers and usually letters, provided they are in the correct 'language.'

There is now a large range of computers on the market, all of which have their own selling points, and it is quite possible to select an application for each of these computers in turn, which would show that particular computer to be better than any of its competitors (where 'better' is some combination of reliability, speed and economy).

The prime external characteristics that distinguish one computer from another are: —

1. Storage capacity
2. Speed
3. Input/output media.

It will be noted from the following brief comments that these three items are very much inter-related.

Storage Capacity. In all electronic computers there are several levels of storage which may

Computer installations vary greatly in size and cost. Here, for example, a small installation—a Burroughs E.101 *desk electronic computer—is contrasted with a medium-sized set-up, an English Electric* Deuce *at The Bristol Aircraft Company Ltd. Even the* Deuce *is tiny in relation to some of the larger models, such as the* Emidec 2400 (*see page* 17).

include delay lines, magnetic cores, magnetic drums or discs, and magnetic tapes or films. (The latter may equally be regarded as input/output media.) The methods of storage listed are in order of decreasing speed and cost.

The total amount of storage available is the first consideration when deciding on the suitability of a computer for a particular application, since space must be found both for programme instructions and data. Many large jobs have been processed on small computers by ingenuity and by splitting the whole into a number of smaller parts, but this invariably means repeated manual intervention with increased scope for error.

Speed. Computers vary tremendously in the speed that they take to perform similar operations. This is dependent on time taken to perform arithmetic operations and also on the time taken to locate data in storage—access time. Delay lines and magnetic cores are both randomly accessible; i.e. the times required to locate information in any parts of the store are equal—of the order of .00001 seconds.

On the other hand magnetic drums and discs are revolving stores, and storage locations come successively under reading heads. Hence, access time depends on the position of data relative to the read-off heads at the time the data is required, and average access time depends on speed of rotation. This method is much slower than core storage.

Finally, tapes or films, being comparatively very slow, are only suitable for storing ordered files which are, moreover, required in the order they appear on the tape.

Input/output media. Despite the fact that a computer is electronic, the components for input and output are mechanical; consequently, input/output operations are much slower than arithmetic operations.

The standard methods of carrying information into a computer are punched cards, punched paper tape, magnetic tape or magnetic film. In addition, certain computers have typewriters attached, by which information can be keyed in directly, and equipment is currently being developed to read typescript.

Certain special purpose equipment can be designed to suit individual requirements; e.g. where data is recorded on scientific instruments, the instruments themselves may be connected direct to the computer, and if the results are required graphically, a plotting machine can also be linked to the computer.

The choice of input/output medium normally lies between punched cards and punched paper tape, and in organizations already possessing conventional punched card equipment the natural tendency is to choose a computer capable of accepting punched cards. Having punched a

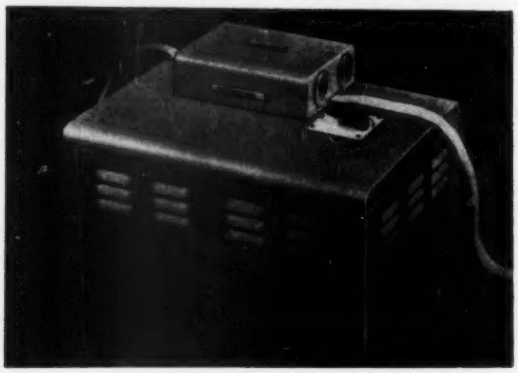
paper tape, processing can proceed only in the computer, and sorting and merging of information must be done either on the source documents, prior to punching, or by the computer. Cards, however, can be processed in a variety of ways away from the computer. In fact, data processing on conventional punched card equipment has been carried out successfully for a large number of years.

Any equipment other than the computer in an ADP system will be either to prepare information for processing on the computer or to prepare the results of a computer run for final presentation.

The first step in the process—the transfer of information from source documents to paper tape or cards—is performed on a punching machine with a keyboard not unlike that of a typewriter, Following this process, the keyed information must be checked, for it is essential that no false information be sent to the computer. It is in this process that cards prove their great flexibility. The punched cards are inserted into a second machine, a verifier, and a second operator attempts to ' repunch ' the cards using the original source documents. If a key depressed at this stage does not correspond to the information punched into the card, the verifier stops and locks up. When an error is found the card containing the error is destroyed, repunched and reverified.

With paper tapes there are two possibilities. The first consists of punching the same tape twice, and then passing both tapes through a comparing machine. This machine produces a third tape so long as the two key-punched tapes are identical, but stops when a discrepancy occurs. Then an operator must key in the correct digit and the machine will continue. An alternative is to use a verifier similar in principle to that used for punched cards, but this one produces a second paper tape identical to the first, until a discrepancy occurs. Then the operator must decide whether the original is correct, key in the digit and proceed.

A paper-tape reader—the Metrovick 960. *This is a compact, self-contained unit which can read standard 5-channel teleprinter tape at a maximum speed of 250 characters per second.*



The important difference between the procedure for cards and tapes is that with tapes error correction cannot be verified. If paper tape has been selected as the medium for input, no processing external to the computer is possible, except for printing the contents of the paper tape. The number of punching and verifying machines required will naturally depend on the volume of information to be punched.

However, with punched cards, much initial processing can take place on inexpensive equipment at far less cost than is possible on the expensive computer. The purpose of any pre-computer processing is to ensure that information reaches the computer in the correct form. This is done by sorting and merging cards on card sorters and collators. Merged packs can also be separated on collators on completion of the computer run.

In completely new installations, however, paper tapes offer several advantages. The keyboards of paper-tape punches are in most respects identical to that of a typewriter, and typists can readily be transferred to punching. Paper tape has the additional advantage of being very much cheaper than cards, and also far less bulky.

Where the computer is slowed down by the speed of a card reader, it is preferable to use magnetic tape as the input. To this end, equipment is available to transfer information from punched cards to magnetic tape, and vice versa, also to print directly from magnetic tape. This equipment is expensive, but where a computer is loaded to capacity and is handicapped by the speed of its input/output devices, the off-line preparation of magnetic tapes can show a large saving.

The first consideration when reviewing any data processing equipment is reliability. Size, speed, and flexibility must always follow behind. For once having installed a computer, or even conventional punched card equipment, the ability to return to manual procedures is quickly lost, and delays due to failure of equipment—down-time—can prove very expensive. Nor is down-time the worst that can happen; it is certainly not unknown for an electronic computer to give a wrong answer through failure of components, or even bad design.

To make a computer completely self-checking is impossible since failure of checking circuitry can never be forestalled. The checking of equipment should not, of course, begin and end with the manufacturer. Apart from regular preventive maintenance and frequent test runs through the equipment, it is essential that many checks, both manual and automatic, should be incorporated into data processing procedures.

Even a comparatively small amount of in-built checking adds considerably to the cost of a computer, but since the more automatic a data processing system may be, the worse can be the consequence of an undetected machine error, any capital invested in reliability is certainly no extravagance.

The main guarantees of reliability that users have are the experience and integrity of the manufacturers. However, even in well-proven equipment, 'oversights' in design have been brought to light after a long period of operation. These can usually be corrected fairly readily once diagnosed.

Some expensive once-for-all items occur with the installation of a computer, for example: —

Safe, efficient storage is essential. There is a host of equipment on the market. Here is a cabinet for storing magnetic tape and punched cards by Punched Cards Accessories Ltd.

Space Allocation. The floor space required by computers and peripheral equipment varies widely, and information on this can best be obtained from manufacturers. In addition to the computer room, space must be allocated for maintenance engineers, punching and verifying equipment and staff, and programmers. In a punched card installation, storage of card files must be planned, as also must be storage of magnetic tapes if a large tape library is envisaged.

The computer room may contain some heavy pieces of equipment, which could preclude its placing on upper floors of existing buildings. This room may also require a false floor to carry electric cables between associated pieces of equipment.

Air Conditioning. A great deal of heat is generated by the computer and its associated equipment, and purely for the comfort of the operating personnel some form of temperature control is required. In addition, if magnetic tapes are being used, a restriction on the ranges of both temperature and relative humidity must be imposed. Tapes subjected to conditions outside those specified by the manufacturer (around 60°-85° F. and 40 per cent-60 per cent relative humidity) become unsuitable for computer processing, though they can be re-acclimatised by storing in the proper atmosphere.

Dust, too, can be a hazard to magnetic tapes, and trouble may be experienced in industrial areas if precautions are not taken to keep the room free from dust. In any case tapes should be stored in containers when not in use.

The best way of finding the difficulties of ADP is by actually detailing an application and then running it through the system in parallel with more conventional methods. Obviously, this can be very expensive but newcomers to the field can often take a short cut by learning from the experience of others. Most established installations, and particularly the service bureaux of the computer manufacturers, are only too happy to discuss their successes, and their methods of overcoming problems.

A. D. P. Names & Notes

ICT Will Be Truly International

WHEN both the shareholders and loan stockholders of the British Tabulating Machine Company and of Powers-Samas Accounting Machines recently approved the merger between the two companies (announced on January 30) they set up a £24 million company which is now the second largest manufacturer of data processing equipment in the world.

The 'international' in the new company's name — International Computers and Tabulators Ltd.—is no accident. Originally conceived with the Common Market and the Free Trade Area in mind, the new company plans to expand considerably the overseas business that was formerly carried out by partner-companies. (British Tabulating previously confined their activities to this country and the Commonwealth, while Powers have sold equipment to European concerns and to a limited extent in North America.)

The company are currently examining the possibilities of manufacturing, or alternatively assembling, abroad, while at home the merger will have two effects: I.C.T. will be able to offer a wider variety of equipment than either partner could before; and the research and development work will be brought within one organisation. However the development work that British Tabulating shared with G.E.C. (Computer Developments Ltd.), and similarly that which Powers shared with Ferranti, will be continued by the new company.

The new company's chairman, Sir Cecil Weir (formerly chairman of British Tabulating) admits that full integration of the two concerns will only be accomplished gradually, stage by stage. For example, production and promotion of the two 'families' of equipment will continue. Later, when it becomes clear where there is exact duplication of equipment, some standardization will be attempted.

However, one problem that the company will have to face before a new range of equipment can be developed will be that of deciding which type of hole I.C.T. punched cards will have. Powers equipment accepts and *senses* a card with an elliptical hole while British Tabulating's cards are perforated with a rectangular hole, and consequently Powers equipment will not work with British Tabulating's cards and *vice versa*.

This problem is important not only for the company's electro-mechanical punched card equipment, for (notwithstanding Lord Halsbury's prophecy that punched cards would be little used in the computers of the future) I.C.T. have reiterated the partner-companies'

NEW INSTALLATIONS

IMPERIAL Chemical Industries recently placed an order for an *Emidec 1100* digital computer for their Plastics Division at Welwyn Garden City.

The computer — due to be delivered in March 1960 — will be used for a variety of clerical data processing work, including stock control of some 33,000 stores items, product costing and wages analyses.

G.E.C.'s Atomic Energy Division will have invested £140,000 in computer hardware by the end of this year. A new analogue machine — an American-built *231 R 'Pace'* computer — was due to be delivered by the end of February, and a second machine, a Ferranti *Mercury* digital computer, will be installed towards the end of 1959.

The new machines will give added computing capacity — the Division already operate a specially-built Elliott analogue machine — and will carry out extremely detailed and accurate calculations necessary for G.E.C.'s extensive programme of developing advanced types of nuclear power stations.

RICKETTS LTD. recently took delivery of a *National-Elliott 405* computer. No details of intended applications are at present available.

APPOINTMENTS

A. MACP. FLETCHER has been appointed Data Processing Sales Manager of IBM (U.K.) Ltd's Glasgow office. Mr. Fletcher who joined IBM in March, 1956, is a chartered accountant.

☆ ☆ ☆

P. D. HALL has been made Manager of Ferranti's Computer Department. 39-year-old Mr. Hall joined Ferranti as a senior electronic development engineer in 1951, was up-graded to Manager of the Electronics Department in 1955.

Successor to Mr. Hall as Manager of the Electronics Department is 31-year-old J. R. PICKIN, formerly chief engineer working on micro-wave devices.

☆ ☆ ☆

A. J. GRAY who has been Works Manager of Ferranti's Transformer Department since 1946 has been appointed General Works Manager of the company.

☆ ☆ ☆

Sunvic Controls Ltd. have appointed MR. C. E. WALTERS general sales manager of all the company's products. New sales managers of other divisions include MR. R. LLOYD, who heads Scientific and Industrial Products, and MR. W. J. DONNELLY, who takes over Data Processing.

confidence in cards as a computer input medium.

Questioned on this point at a recent Press conference, tongue-in-cheek I.C.T. executives were inclined to opt for a new triangular hole. Nevertheless serious study of this problem has begun, and already it has been agreed to standardize on an 80-column card. Also, research is going on into the problem of using both types of cards on one existing type of equipment.

However, almost certainly, future I.C.T. equipment will make use of one type of card exclusively. *Which* type will interest many people—not least I.B.M. whose card is similar to the British Tabulating card, and whose equipment is in certain cases interchangeable with British Tabulating's.

★

TWO management computer courses already held by the recently formed company, Urwick Diebold Ltd., dealt with specific aspects of ADP 'know-how.'

— First course, held from February 9 to 13, dealt with 'How to manage and control ADP.'

— The second course studied the use of ADP for production planning and inventory control.

The company, which was established late last year, was jointly formed by John Diebold & Associates Inc. (U.S.A.), and Urwick Orr & Partners Ltd. to offer a computer consultancy service to British firms. The American partner is the largest American consulting firm specializing in data processing work, while the British partner is one of the major management consultant firms in the country.

★

ANOTHER newcomer to the computer consultancy field, Computer Consultants Ltd., promise to offer to users or prospective users of ADP equipment a number of services that extend from advising in the first place whether a company should consider an installation to making suggestions for more effective use of existing installations.

★

HIVE-OFF from James Gordon & Co. Ltd., a member of the Elliott-Automation Group, is James Gordon Valves Ltd. The new company will handle the design, manufacture and sale of the specialized Gordon range of control valves, which include tight-shutting butterfly valves developed during recent years.

★

A USEFUL limb of the British Institute of Management's Information Service is its *Visual Aids Information and Advisory Service*. In addition to expert advice on the making and use of industrial films and film strips, the Visual Aids branch can advise on available films and put inquirers in touch with sources of all types of visual aids, and with persons and bodies more directly concerned with this specialist field.

A register of films and strips is kept by the Service and the 35 subject sections include Automation, Electronic Control, and Electronics, and Data Processing.

Courses & Exhibitions

1-3 April
Residential Working Conference on Automatic Programming. (Director of Studies: Dr. A. D. Booth).

Venue: Brighton Technical College.

Enquiries: The Registrar, The Technical College, Richmond Terrace, Brighton.

2 April
One day conference on the use of computers for Production Control.
(Organised by the Central London Productivity Council and the Northampton College of Advanced Technology).

Venue: Northampton College of Advance Technology, London.

10-12 April
Weekend course in Electronic Data Processing.
(Organised by the Association of Certified and Corporate Accountants).

Venue: Oxford.

11-13 May
Symposium on Instrumentation and Computation in Process Development and Plant Design. (Organised by the Institution of Chemical Engineers, the Society of Instrument Technology, and the British Computer Society).

Venue: The Central Hall, Westminster.

Enquiries: to the Institution of Chemical Engineers, 16 Belgrave Square, London, S.W.1.

21-27 May
International Convention on Transistors. (Organised by the Radio & Telecommunications Section of the Institution of Electrical Engineers).

Venue: Earls Court, London.

Enquiries: to the Institution of Electrical Engineers, Savoy Place, London, W.C.2.
Running currently and associated with the Convention: International Transistor Exhibition.

15-20 June
International Conference on Information Processing.
(Organised by U.N.E.S.C.O.).

Venue: Paris.

Enquiries: to the Hon. Secretary, Group B, British Conference of Automation and Computation, c/o The Institution of Electrical Engineers, Savoy Place, London, W.C.1.

22-25 June
First Conference of the British Computer Society (Papers and symposia on varied aspects of ADP).

Venue: Cambridge.

Enquiries: to the British Computer Society Ltd., c/o University Mathematical Laboratory, Cambridge.

New Techniques & Equipment

MACHINE READS OPTICALLY OR MAGNETICALLY

E.M.I. ELECTRONICS LTD. have developed FRED, a Figure Reading Electronic Device, which can read either optically, like its human counterpart, or magnetically with the aid of specially prepared inks at speeds of many thousand characters a second. Both methods have widespread uses, but where documents to be read have to be passed through several hands and are likely to accumulate overprints or defacements, the magnetic system has definite advantages.

A special type face that varies in appearance from standard numerals, has been designed to allow maximum tolerances. The accuracy of size and shape is well within the capabilities of all the normal printing processes.

The possible applications of FRED are only just beginning to become apparent. In its magnetic form it is ideally suited for reading cheques and invoices for the purpose of sorting or feeding information into accounting machines. Cash register entries can also be scanned and the information fed into a central accounting system, thus keeping an up-to-the-minute check on cash takings, throughout a large store or chain of businesses.

As a computer input system the equipment offers great advantages. Much of the information which is now fed into computers by means of punched cards or perforated tape can be prepared ' in clear ' and read automatically into the computer.

FRED can also be used for reading route information or serial numbers of objects on conveyors or railway trucks. The logic of the circuits in FRED enable fifteen characters of which the Arabic numerals 0 to 9 will normally be included with alternative options for using the other five. The figures 10 and 11 in the pence column of an accounts entry can be read as single digits, and a wide range of conventional symbols can also be provided.

The characters are read by moving them smoothly past the reading head. There is no need to bring them to rest or centralise them. This relative motion can be achieved either by moving the head, or the characters themselves.

E.M.I. Electronics Ltd., Hayes, Middlesex.

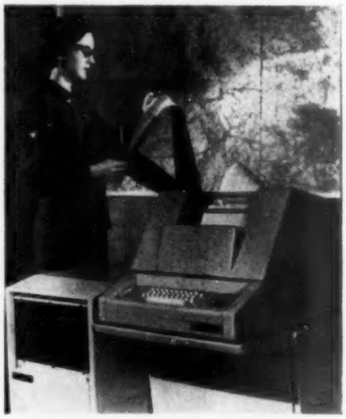
Possible applications for Fred, the reading device, extend from reading cash register entries to complete invoices.

IN TOP GEAR— 500,000 WORDS A MINUTE

BURROUGHS CORPORATION has developed an electronic teleprinting device that receives messages automatically and produces a printed copy at speeds up to 3,000 words a minute. Operating at this speed the new electronic-teleprinter will still be running in low gear. Further developments will give the unit a theoretical top speed of 500,000 words a minute. This would enable it to print three full-size novels in a minute.

Development of the electronic teleprinter was the result of the joint efforts of Burroughs Corporation and the United States Army Signal Corps Research and Development Laboratory. The unit will play the major role in the army's new system of associated teleprinter units all operating at 750 words a minute.

The basic design of this ultra-high speed military communications printer, says the company, makes it easily adaptable to civilian applica-



Machine receives radio and telephone signals.

tions, such as sending out weather forecasts, stock exchange reports, telegraph messages and news reports.

The teleprinter shoots letters electronically at a coated paper through a series of electrode ' guns ' that aim their beams at rapidly moving paper. Each line of text passes over powdered ink and a heated roller and it appears a split second later as clean, dry, readable type.

The machine can operate from standard code tape or can be plugged into a long-distance radio or telephone circuit to print out pulse

messages from across the continent or overseas. In mass production the high-speed printer is expected to cost only half as much as a series of eight standard printers it can replace.

Burroughs Adding Machine Limited, Avon House, 356/366 Oxford Street, London, W.1.

READER WILL BE LINK IN AN ADP SYSTEM

THE Electronic Department of the Sweda Cash Register Factory, Sundbyberg, Sweden, has developed a new electronic reader of printed characters on audit strips from its cash registers. It is meant to be used as a link in an automatic data processing system.

The audit strip, with coded characters, is printed in an ordinary Sweda cash register. The audit strip, taken out of the machine in the usual way, is dispatched to a centre where the Sweda E-3 reader records the information printed on the strip.

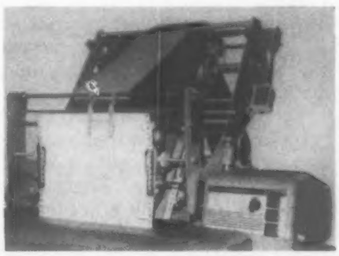
When the audit strip arrives at the Centre, the operator, seated in front of the reader, puts the strip with an easy hand movement into the strip-winding mechanism, and presses the start button. The strip passes by a slot through which the printed characters are projected on photocells, the impulses of which are led to an electronic computer or memory. The reader stops automatically if the character has been badly printed, or if stains on or in the paper make a character 'unreadable,' in which case a correction is made by the operator and the reader is started again.

This new product is an approach to the solution of many data handling problems in department and chain stores.

Sweda Cash Register Factory, Sundbyberg, Sweden.

PERFORATIONS ENSURE DOCUMENTS TRAVEL TOGETHER

NOW on the market by Fanfold Limited is a sprocket-punched carbon interleaved stationery for a variety of uses in automatic data processing. One of the advantages claimed for this stationery is that documents which travel together remain joined together (complete with carbon paper for subsequent writing) yet at the same time forms can be detached easily and quickly. Among others, this feature is useful when the user wishes to send out two documents one of which should be returned. Accurate registration is ensured since the forms are printed and punched in one operation and held together by a stub at one side and perforations at the other.



Sweda's electronic reader (left) will read audit strips from Sweda cash registers. Sprocket-punched carbon interleaved stationery (above) gives accurate registration.

The company has also introduced what it calls 'the hectographic attachment to the *Carbaline Feed*,' in order to increase economy and efficiency in the production of spirit duplicating masters on tabulators. This is done through feeding the master paper and hectographic carbon independently so that the master will space and throw as required but the carbon only feed when the tabulator prints. The feed rate can be so varied as to give a virgin area of hecto for each line of print on the master.

Fanfold Limited, Bridport Road, Edmonton, London, N.18.

FAST TAPE PUNCH FOR 'ON-LINE' WORKING

ANOTHER machine to attract great interest at the Computer Exhibition was the new Creed Model 3,000 Tape Punch which has been designed expressly to record the output of electronic computers in 5-, 6-, 7- or 8-track punched paper tape at a speed of 3,000 words per minute (300 characters per second.) The nine reels of punched tape seen in the picture represent one hour's work on the machine during which over 1,000,000 characters are recorded.

The company point out that, as punching is 'on-line' working, i.e. direct connection to the computer, much saving of valuable computer time is thereby achieved.

The machine may be operated either by repeating the trip pulse once every character (pulsed operation) or by employing a continuous trip pulse which allows the machine to punch freely at its maximum speed (synchronous operation.)

It is available in three versions:

1—A narrow-tape version which punches five code tracks on 11/16in. wide tape.

2—A medium-tape version which punches six or seven code tracks on $\frac{7}{8}$in. tape.

3—A wide-tape version which punches eight code tracks on 1in. tape.

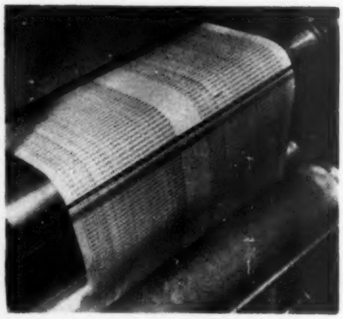
A motor-driven tape supply and winding mechanism automatically keeps the tape at correct tension and there is an optional code 'check-back' facility. Another feature is a 'tape-low' warning device.

Price and delivery details are as follows:—

5-track tape version £2,500 each
6- and 7-track tape version £2,600 each
8-track tape version £2,700 each
Extra for optional check-back facility—all models £150 each.

Prices are ex-factory and delivery time is approximately nine months from receipt of order.

Creed & Company Ltd.,
Telegraph House, Croydon, Surrey.



Creed's tape punch (left) will punch 300 characters per second. Any type face may be used with the *Xeronic* fast output printer (above).

BEAM OF ELECTRONS WRITES 1,500 LINES A MINUTE

ONE of the most remarkable ADP advances in recent months has undoubtedly been the *Xeronic* Computer Output Printer developed by Rank Precision Industries at their Research Laboratories in Shepherds Bush.

The experimental model on display at the Computer Exhibition prints 1,500 lines a minute—and this will be increased to 3,000 lines a minute. At Olympia, pre-printed forms were used, but plans are already well ahead for it to print its own forms at the same time as it prints the computer's output, giving greater flexibility to the system and considerably reducing the running costs. By coding certain instructions or 'orders' in the input, the layout of data on the form may be arranged as desired.

This tremendous advance in speed of print-out has only been made possible by an entirely new approach to printing in this field. Mechanical methods, with type and ink have been replaced by tools of the modern age—the transistor, the cathode ray tube and xerography. The tyranny of slow-moving mechanical parts has been broken, say the inventors, so that this printer bears the same relation to mechanical printers as the computer does to the adding machine.

This printer works either from the computer's output recorded on magnetic tape or straight from the computer's buffer store. A beam of electrons writes the letters and figures on an ordinary cathode ray tube, and they are instantly copied by xerography.

The xerographic machine used is the Rank-XeroX Copyflo Continuous Printer. This copies an original (whether it is on paper or on a cathode ray screen) on to plain, unsensitized paper at the rate of 20 feet a minute. The process, which is completely dry and automatic, works by electrostatics.

For the printing, any styling (or 'typeface') can be used, with capitals and small letters and italics if required, and the number of characters it can print is not limited. The unit displayed at the Exhibition had a repertoire of 50 characters, printing up to 128 characters across paper 13ins. wide and the input from magnetic tape. The final model will use paper 26ins. wide and will produce 2 copies of 128 characters each or 4 copies of 64 each per line.

Rank Precision Industries Ltd.,
37/41 Mortimer Street, London, W.1.

NEW PHOTO-ELECTRIC READER FOR PAPER TAPE

A PRECISION photo-reader—*Model 440*—has been developed by Burroughs Adding Machine Co. This reads perforated paper tape by a photo electric process at the fast rate of 1,000 characters per second, from a code density of 10 characters per inch. Tape speed is 100 feet per second. Rapid tape start enables the first character to be read within 5 milliseconds, and the ability to stop positively on the 'stop' character at all operating speeds so that the following character has not reached the photo-diode area and will not be read until the restart, permit maximum programming flexibility. Reduced operating speeds are optional to a minimum of 250 characters per second.

The company announce that in their *220* Computer system, provision is made for on-line use of up to ten photo-readers.

As a solution to the computer output problem Burroughs have

developed a new ' solid-state ' system which will select, edit and print out from either a computer or a magnetic tape at speeds up to 1,500 lines per minute, with 120 print positions to each line. This new *220 High Speed Printer* represents a step towards freeing electronic data processing from the delay caused by slower electro-mechanical output devices that cannot keep pace with the speed of computer calculations. It consists of two units: a printing unit and a control box, both housing a magnetic core buffer, plugboard editing controls and power supplies. All logical and control circuiting is transistorized.

The printer turns out solid face copy on multiple forms used in billing, management reporting, customer statement and other high volume printing applications. Even in applications running at speeds over 1,200 lines per minute, the solid face is highly legible right down to and including the last carbon copy.

Burroughs Adding Machine Ltd., 356-366 Oxford Street, London, W.1.

WITH ONE COMPUTER—THREE ADP SYSTEMS

A NEW electronic digital computer specifically designed to speed commercial office routine is being introduced by Ferranti Ltd. Called ' Pegasus 2,' the new computer forms the centre of three different data-processing systems.

The first system is known as the ' converter ' data-processing system. Its unique feature is its ability to turn out a high volume of work because the converter and ancillary magnetic tape equipment ensures that all the units in the system work at their optimum capacity. In addition, the converter can operate on ' off-line ' working techniques, which can be preparing the next job for the computer or printing out the results from the previous job while the computer is engaged on a current project.

With *Pegasus 2* a variety of peripheral equipment can be used.

The second system is known as the ' direct ' data-processing system whereby information on punched cards can be passed directly into or out of the computer. This system promotes great versatility and can be integrated with existing systems that already employ punched card installations.

The third system is the ' common language ' data-processing system, an entirely new and unconventional approach to data-processing work. This exploits new techniques and equipment for using punched paper tape as a data-processing medium.

Existing office machines such as typewriters, cash registers and accounting machines can be used in the ordinary way, automatically producing punched paper tape which provides the ' common language ' link between all the machines integrated in the system with the central computer.

The system will be of value to organizations that do not employ punched cards, or for those organizations where information is derived from many different and geographically dispersed places but must be processed centrally; for example, groups of companies, chain stores and hospitals. Information may even be sent from overseas agencies by Telex line, by utilising new checking techniques.

Cost of the data-processing installations range from approximately £55,000 for the basic computer to £180,000 for a complete converter system.

Ferranti Ltd., Hollinwood, Manchester, Lancs.

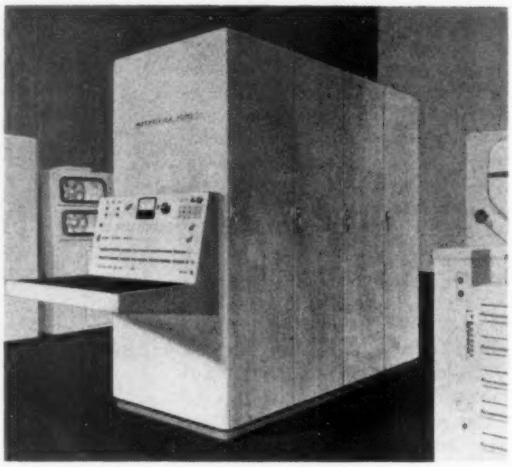
VERY SMALL MEMORY SYSTEMS ON THE WAY?

SCIENTISTS at The National Cash Register Co. Research Laboratories in the U.S.A. have developed a tiny magnetic device which will increase the ' thinking ' speed of electronic digital computers and missile guidance mechanisms by as much as 10 or 12 times.

This device—a pin-sized glass rod with a magnetic coating—will serve both as a switching and an information storage element.

This development represents a remarkable break-through for the rod is capable of recording and releasing information at impressive speeds—between 25 and 250 microseconds. Also, the device will operate efficiently at temperatures 300° Fahrenheit higher than conventional components.

Rods can be linked together electrically within a very small space. For example, a rod memory system the size of a small packet of cigarettes could store 8,000 ' bits ' of information. Consequently not only should they reduce the space needed to handle electronic computing problems of all kinds but these rods should considerably improve the speed of handling information in data processing systems and also provide ' solid state ' reliability—a most important factor in continuously operating systems.
The National Cash Register Co. Ltd., 206-216 Marylebone Road, London, N.W.1.



The *Metrovick 1010* data processing system, of which the first equipment wil be completed in mid-1959 will make use of the Decca high speed twin tape deck and the Powers-Samas *Samastronic* output printer.

CARRIER CHANNELLING EQUIPMENT IS TRANSISTORIZED

AUTOMATIC TELEPHONE & ELECTRIC CO. are now manufacturing fully transistorized carrier channelling equipment.

The equipment, has been designed to assemble blocks of 12 speech circuits and, where required, associated outband signalling paths, into basic groups suitable for application to the terminal equipment of all ATE multi-channel carrier telephone systems.
Automatic Telephone & Electric Co. Ltd., Strowger House, 8 Arundel Street, London, W.C.2.

ELECTRONIC STRIP CHART FOR DATA RECORDING

NEW ADDITION to the George Kent range of industrial control instruments is the *Mark 3 Multelec* electronic strip-chart indicator-recorder. The *Mark 3* is at present available for precision measurement of millivoltage, and also temperature, in association with thermocouple, resistance thermometer or radiation pyrometer.

Salient features of the unit are an operating speed—with no pointer ' overshoot '—of two seconds only for full-scale travel; all-mains operation with continuous standardization; redesigned chart-drive unit, permitting variation of chart speeds from 1in. per hour to 4in. per minute; 10in. chart width and pen travel; extremely sensitive, high-gain amplifier, covering a wide range of a.c. or d.c. input conditions; sealed-unit servo-motor with built-in tacho-generator; and a synchronous converter capable of detecting smaller signals than any other available.

The *Mark 3 Multelec* is available in single or multi-point form, with point-cycle times of 5, 10 or 20 seconds, depending on application, enabling up to sixteen variables consecutively to be measured and recorded with laboratory accuracy.
George Kent Ltd., Luton, Bedfordshire.

FAST TAPE DECK STOPS IN FOUR MILLISECONDS

E.M.I. ELECTRONICS LTD. is manufacturing a new series of EMIDATA components. Included amongst these is a Fast Start/Stop Digital Tape Deck, which combines very high speed and fast start, stop and reverse times with electrical and mechanical reliability. Bi-directional tape speeds of 200in./sec. with start and stop times of 4 milliseconds, are achieved by an advanced design of vacuum capstan.

Located below each main drive capstan is a tape bin which provides buffer storage between the tape spools and the capstans. These bins are electrically sensed to measure the amount of tape in them and the tape in each bin is maintained at a pre-determined level by the servo controlled main tape spools and vacuum binning capstans.

The equipment has the following special features:—

1—Out of contact operation with no wearing of oxide surface of tape.
2—1in. tape 2,400ft. spools and up to 24 channels.
3—Bi-directional tape speed of 200ins./sec.
4—Easy tape threading and fully automatic operation.

The company has also developed a new instrumentation tape deck specially designed to meet the requirements of the data processing

engineer. Four of its speeds within the range ½ to 120in./sec. can be selected instantaneously, and up to 24 channels on 1-inch tape provided. Tapes made on one machine may be replayed on another of the same type. The equipment, which has been designed to give utmost flexibility to meet the diverse needs of modern data processing systems, provides 4- or 6-tape speeds on any deck.

The EMIDATA Type 'B' range of magnetic heads have been developed to meet the need for an inexpensive but reliable unit for digital work. They are designed for 'out of contact' operation on magnetic drum and tape stores. Both the type 'A' and 'B' designs afford the highest standards in precision manufacture and mechanical stability, resulting in a high performance of the standard required for modern digital data processing.

E.M.I. Electronics Ltd.,
Hayes, Middx.

HOOK-UP GIVES A PUNCHED TAPE PLUS INVOICE FLOW

ON show for the first time at the Electronic Computer Exhibition was the *Formaliner* continuous form-feed appliance for use in conjunction with the Friden *Flexowriter* which is marketed by Bulmers (Calculators) Ltd.

The *Formaliner* is a lightweight, flexible attachment which is fitted above the platen of the *Flexowriter*. It involves no modification to the machine itself and, by simple adjustment, the tractors can accommodate wide or narrow stationery.

The *Flexowriter* is itself so constructed to allow tape to be punched with all typed data or with selected items only. Whichever method is employed, *Formaliner* equipment plays an integral part in the flow and control of the output. An additional aid is a line-finding device which provides vertical spacing control at pre-determined points.

Paragon continuous stationery, for use with the *Flexowriter*, is marginally punched with small holes at regular pitch to engage the *Formaliner* tractors to which it is held securely by spring gates. Forms can be interleaved with 'one-time' carbon or supplied with 'carbac' treatment, or supplied with no carbon at all, as desired.

Lamson Paragon Limited,
Paragon Works, London, E.16.

A form-feed appliance linked to a *Flexowriter* can provide input data for a computer as well as producing a document, such as an invoice.

In addition to fast speeds this tape deck has the advantage that the reading heads do not touch the oxidised surface of the tape.

The Next Computer Generation — *BY DR. A. BOOTH*

(continued from page 19)

material have been made. This, however, is as far as work in this field appears to have gone. Of course, in the United States parallel work has been going on with respect to Russian and in Russia a vast quantity of work on all sorts of language combinations is at present in progress. Nevertheless, all this work is in an experimental state and none of it has come to the stage in which machines are displacing human translators.

In the fields of Economics and Commerce we find a far more discouraging situation. Naturally one of the first applications of computing machines was to the computation of P.A.Y.E. This is a most unsuitable application for any high speed automatic digital calculator for a number of reasons which it is not possible to go into here, but from this pedestrian start computers have been applied to stores control (another singularly pedestrian calculation) to problems of traffic queueing both on roads and railways and to the scheduling of railway timetables.

Various other minor applications have also been made, for example, in a very small way to production control, but, by and large, no application has yet taken place to such things as strategic planning and, as we shall see when we come to consider the future, it is in this sort of field that progress is likely to lie.

Perhaps some of the difficulty has been caused by business men and accountants themselves. In the early days of computing machines they proved themselves singularly unco-operative on a financial plane as far as research was concerned, and when the first, rather stumbling, machines became available, they were slow to take them up and quick to criticise the work of other people carried out under great difficulty and with no help or encouragement from themselves.

It is also fair to say that experience in business computation at the present time has been that, generally, the installation of an automatic computing machine never saves either money or staff.

On the other hand, in a few cases where careful thought has been given to the integration of the machine with existing procedures, although the net cost of the operation has gone up, so too have the profits of the companies concerned. So here at least is an indication of the way in which future progress is likely to be made.

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